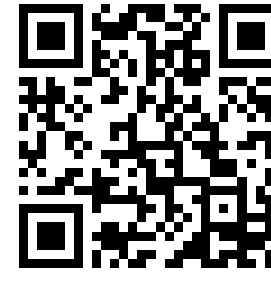


Math.-Mech. Institute
of
G. Coradi
Zurich 6
(Switzerland)

Mathematical Precision Instruments

Edition
1915.

AWARDS:

Zurich 1883: Diploma :-: Paris 1886: Medaille d'argent :-: Zurich 1894: Diploma of Honour :-: Paris 1900: Grand Prix :-: St. Louis 1904: Grand Prix

Mathematical-Mechanical Institute

of

G. Coradi

Zurich 6 (Switzerland)

49 Weinbergstrasse

Telegraphique adress: **„Coradige Zurich"**

Catalogue

of

Mathematical Precision Instruments

Edition 1915

Without Engagement

Prices in special list.

INDEX

NOTICE

1. Letters and remittances should be sent postage paid; the postage on letters to Switzerland is 2½ d (5 cents); Post cards 1 d (2 cents).
2. The prices are understood to be for net cash for delivery at my works at Zurich and are quoted in Francs in a separate list. Foreign monies and money orders are accepted at the daily rate of exchange.
3. Packing, which is carefully done, will be charged at cost price; the packing is as a rule not returnable.
4. I guarantee the strong and accurate construction and exact adjustment of my instruments.
5. Instruments are sent for account and risk of the buyer, as a rule for cash with order or on delivery. Persons known or recommended to me, as also Municipal Authorities and Institutes may remit the amount after receipt and testing of the goods or according to special agreement.
6. *I cannot send any instruments on approval,* but shall be pleased to give intending purchasers the benefit of my long experience with regard to selection.
7. Pantographs and Planimeters are always kept in stock and can be delivered immediately after adjustment. Integraphs and Coordinatographs are always in course of construction and buyers are requested when ordering to make enquiries as to delivery time. The other instruments are only made to order and a longer delivery time is therefore required for these.
8. No reductions in price can be made.
9. As I am always endeavouring to further perfect the instruments by means of suitable improvements, the illustrations do not always entirely represent the actual construction; whenever this is the case it is mentioned in the text.
10. Customers are requested to give their *full address,* mentioning the nearest *railway station* and whether the goods are to be sent by *passenger train, goods train or post,* and, if necessary, by what route. When ordering goods by wire it is sufficient to state the catalogue number and the number of instruments required. Telegraphic orders are executed in accordance with the wording of the telegram but no guarantee can be given for mistakes which may occur owing to errors in the telegrams; it is therefore recommended to immediately confirm the order in writing.
11. *The offer made in this catalogue and price list is without engagement. I do not accept a legally binding delivery time,* but I always endeavour to keep the delivery time stated in my confirmation of the order.
12. All previous editions of catalogues and price lists are cancelled.

Zurich 6, 1915.

G. Coradi.

A.

Freely suspended Pantographs.

Literature of reference:

von Schlieben, Handbuch der Vermessungskunst, 9th Edition, by W. Caville, Page 468.
Brönnimann, Katastervermessung, Bern 1888.
Zeitschrift für Vermess.-Wesen, Volume V, Page 93, Volume VI, Page 368.
etc.

A description and directions for use are supplied with each Pantograph.

The best, most accurate and most advantageous instrument for making reductions and enlargements of plans and maps; unsurpassed, improved construction.

Advantages.

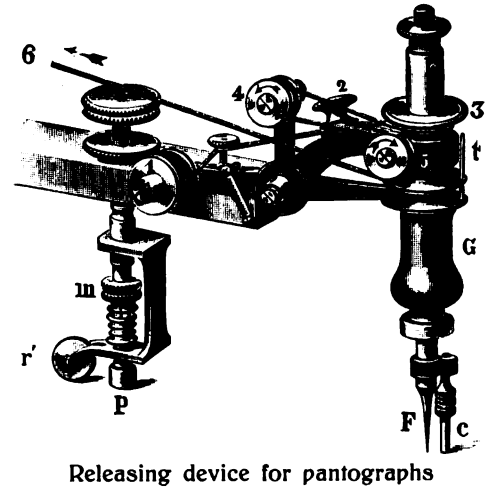
1. Owing to the improved and extremely accurate construction of all parts of this instrument the reduction is **most accurate** and generally exceeds all expectations.

2. The instrument is extremely easy to set up, handle and guide, so that any profile can be traced as in writing.

3. With no other instruments can enlargements be made so easily and reliably; these instruments are set up in the same way for enlarging as for reducing and are consequently equally accurate in both operations. In enlarging the error only increases proportionately to the unavoidable error of the setting and tracing.

4. The graduation of the bars of instruments I—III can be used for the accurate setting to any desired ratio, the zero of the graduations exactly corresponding to the centre of the axes.

5. The guiding of the instrument and the handling of the **releasing device** for raising and lowering the pencil and pricking points is easier than with any other pantograph. Both operations are done by means of the handle *G* (see illustration) and only require the use of the right hand, so that the left hand can be used for relieving the top part. The releasing device is adapted to the involuntary movement of the hand when beginning and ending the tracing of a line. On pressing down the handle *G* the pencil point is also pressed on to the plan and can be fixed in this position by turning the handle *G*. If the handle *G* is raised, the pencil point is also raised and kept in this position by



Releasing device for pantographs I, II and IIIa.

a spiral spring on the releasing lever. **For using the pricking point by changing the fulcrum of the spiral spring its elasticity can be so increased as to be able to draw the point out of the paper and keep it suspended.** By these improvements the use of pantographs is greatly facilitated and less fatiguing.

6. The tracing, pencil and pricking points in all these pantographs keep steady by their own weight; they are brightly polished and nickelled so that they do not rust and are easily kept clean. The tracing point is furnished above its socket with a nut and spring sleeve, by means of which it can be adjusted to any height and used directly for pricking when enlarging. This device facilitates accurate setting at a determined point; by adjusting the small support *c* on the tracing point underneath the socket the tracing point can travel just clear of the paper whereby a very accurate tracing is obtained and the original plan is not injured by the tracing point. **On the pricking point a cap is screwed which prevents the point penetrating too far into the paper, enables the size of the prickings to be regulated and protects the point when not in use.** The Faber and L. & C. Hartmuth leads can be used in the pencil point.

7. The instrument can be used on any ordinary table which is sufficiently level and large enough to take the frame, original and copy. Drawings can also be made on objects of a certain height (for instance litho stones). It is only necessary to raise the frame and original accordingly.

Owing to the above advantages my pantographs have gradually overcome the former prejudice against the use of such instruments (which was due to the inaccuracy and difficult handling of the older instruments on casters). Over 3500 pantographs, mostly of the largest kind, have been supplied by me.

Instructions for use and a table for setting accompany each instrument.

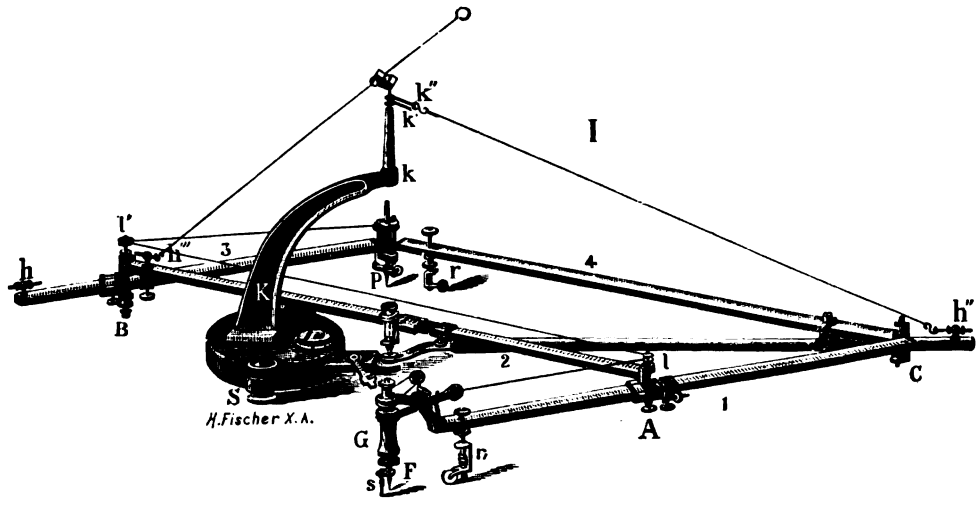
The pantographs with bars 60 cm (24") long enable **when set** to $^1/_2$ a square of 50 cm (20") side or a rectangle of 40×60 cm (16×24") to be traced; those with bars 96 cm (38") long can trace a square of 80 cm (32") side or a rectangle of 120×70 cm (48×28"). For the ratios above $^1/_2$ up to $^4/_5$ the area that can be traced becomes smaller and for the ratios below $^1/_2$ to $^1/_{20}$ accordingly larger.

Owing to my own experience I cannot too warmly recommend the precision pantograph, which works with perfect accuracy and has met with the greatest approval on the part of all Public Authorities, designers, draughtsmen and others who have bought such instruments from me and use same.

The bars of all pantographs are nickelled to prevent rust and are therefore preferable to brass bars.

Pantograph, *Type I* (see figure I) for copying, reducing and enlarging in all ratios.

The bars are hard drawn, square, brass tubes, graduated in millimeters with verniers for 0,1 mm. on the sleeves and micrometer adjustment; bars are connected by pivot joints. Very easy release by means of a moveable sleeve concentrically embracing the sleeve of the tracing point and serving as a guide. The caster on the tracer arm is provided with a spiral spring, the effect of which can be regulated by means of a screw nut. The ratios from $^2/_3$ to $^1/_{20}$ are set with the pole at the end, the ratios from $^2/_3$ to $^1/_1$ to $^3/_2$ are set with the pole in the centre. For this purpose the pole and pencil points are interchangeable in their sleeves. The part of the instrument to be supported is suspended from a diagonal supporting tube underneath the instrument; this tube rests against a steel cylinder screwed in the frame; the centre of this cylinder carries the ball bearing of the pole, **so that the tension of the suspending wire produces no strain on the pole joint.** The frame carries two screws and a spirit level for the vertical adjustment of the axis of rotation of the instrument; there is a small level for the horizontal adjustment of the bars, one tracing point, two pricking points, one pencil point, all nickelled; the bars are nickelled to prevent rust. An elegant polished case with strong lock and handle.



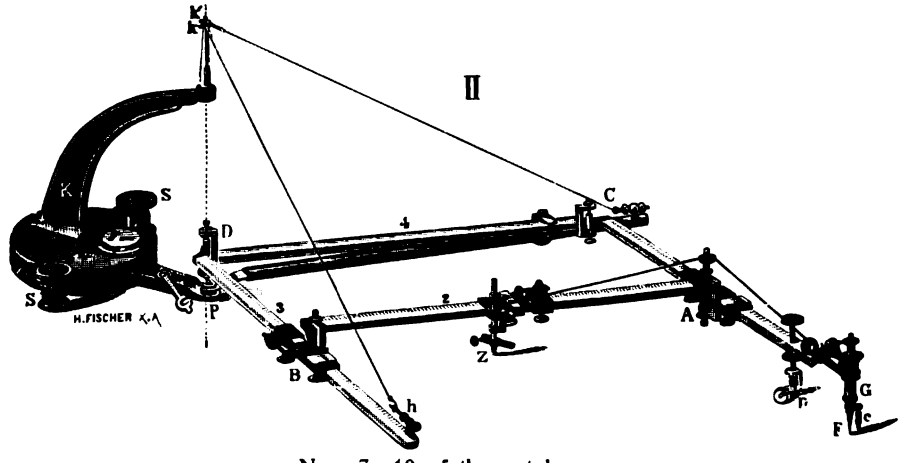
Nos. 1—4 of the catalogue.

Prices:

No.

1. Length of the bars **60** cm (24") . . . . . Fr.
2. „ „ „ „ **72** „ (28") . . . . . „
3. „ „ „ „ **84** „ (33") . . . . . „
4. „ „ „ „ **96** „ (38") . . . . . „

5. A further nickelled suspension tube, instead of the caster on the pencil point, to keep this part of the instrument also suspended, when, for instance, tracing with the pole in the centre direct from litho stones or copper plates on to wax sheet, in order to protect the latter from injury by the caster, together with supporting roller, according to length . . . . . Fr.
6. A similar suspension tube, instead of the caster on the tracer arm, to keep also this freely snspended when valuable originals (oil pictures, photographs etc.) are to be traced and it is essential to avoid touching the same with the caster. **For instruments of 60 cm (24") length only** . . . Fr.



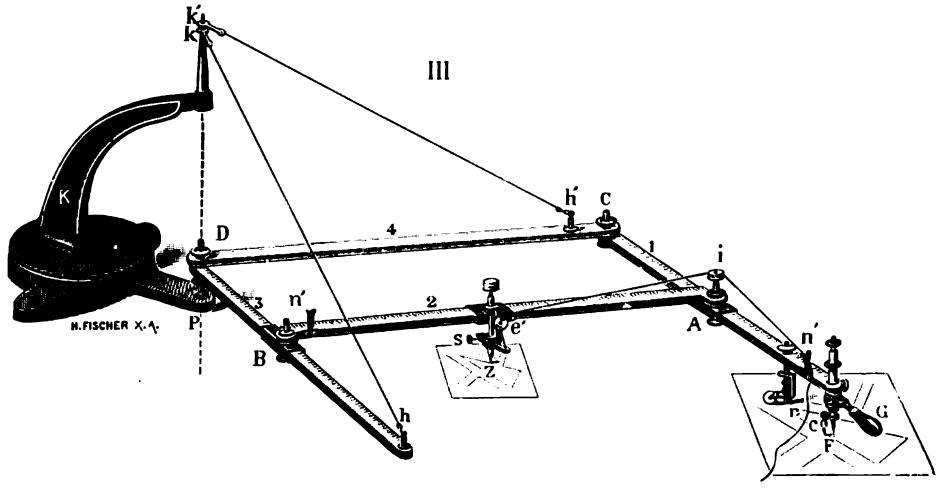
Nos. 7—10 of the catalogue.

Pantograph, *Type II* (see figure II), the same as Type I, but exclusively for reducing and enlarging in all ratios from 1/20 to 4/5 (can only be used with pole at the end). In all other respects as in I; this type of pantograph is also provided with a supporting tube, placed under bar 4, and resting against the steel cylinder fixed in the frame and the **sole** purpose of which is to prevent the tension of the suspending wire producing any strain on the pole joint.

No.

7. Length of the bars **60** cm (24") . . . . . Fr.
8. „ „ „ „ **72** „ (28") . . . . . „
9. „ „ „ „ **84** „ (33") . . . . . „
10. „ „ „ „ **96** „ (38") . . . . . „

Without micrometer adjustment types I and II cost Fr. . . . less.



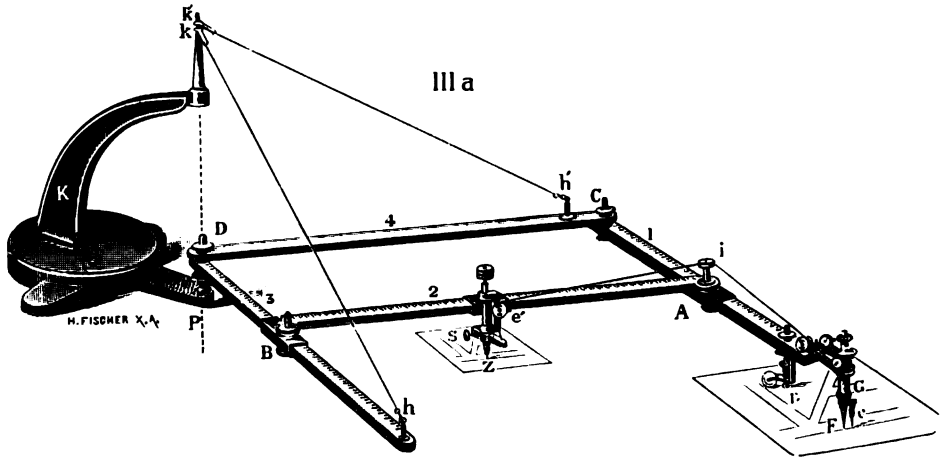
Nos. 11—14 of the catalogue.

Pantograph, *Type III* (see figure III) for reducing and enlarging in all ratios from 1/20 to 4/5. The bars are hard drawn, square, brass tubes graduated in mm. On the sleeves are plated bevel edges for setting ratios. Joints working in well fitting taper steel axes. Simple release; without screws, without level and without bolt on the frame. One tracing point, one pricking point and one pencil point, all nickelled. Bars nickelled. Elegant polished case with strong lock and handle.

No.

11. Length of the bars **60** cm (24") . . . . . Fr.
12. „ „ „ „ **72** „ (28") . . . . . „
13. „ „ „ „ **84** „ (33") . . . . . „
14. „ „ „ „ **96** „ (38") . . . . . „

The Pantographs Type **III, IV and V** are so suspended, that the axis of rotation of the instrument is at once rectangular on a level board and the bars of the instrument move parallel to the board. Neither the board nor the instrument need be placed exactly horizontal.



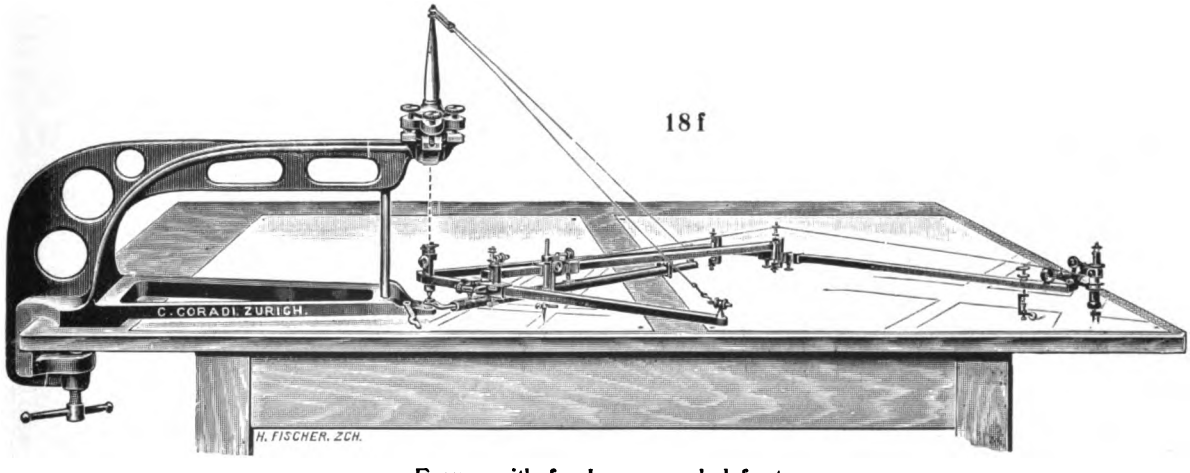
Pantograph, Type III with releasing device as for types I and II (IIIa).
Nos. 11—14 of the catalogue with extra a.

Nr. **Extras to No. III.**

15. a) Releasing device as in I . . . . . Fr.
16. b) Screws, level and bolt on frame, and moveable level for horizontal adjustment of bars . . . . . „
17. c) Verniers and micrometer adjustment . . . . . „
18. d) Copying device ($^2/_3$—$^1/_1$—$^3/_2$) as in I; according to the lengths of the bars „
18. e) Glass mark and magnifying glass at the tracing point . . . . . „

NB. The extras No. 15a, 17c and 18d cannot be supplied subsequently; if required, they must be ordered together with the instrument.

No. 18d (copying device) also requires No. 16b (device for horizontal adjustment).



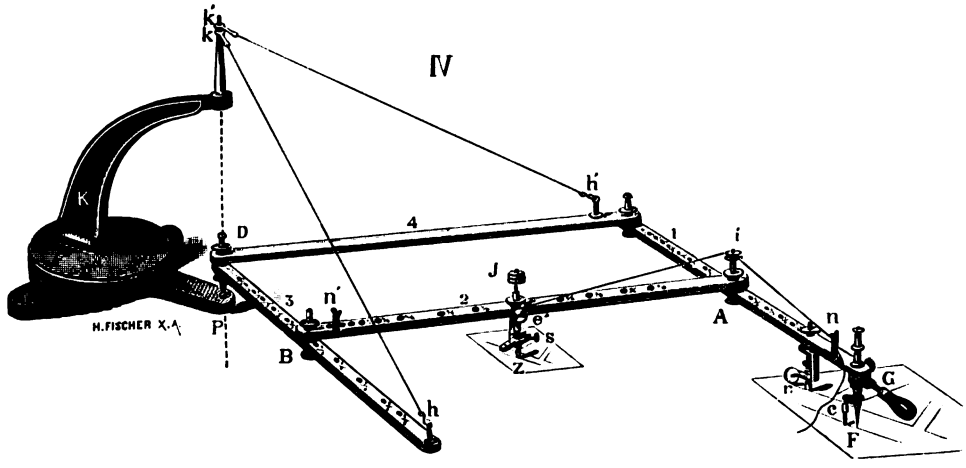
Frame with freely suspended foot.

No.

18. f) (see figure 18f). This frame ist screwed on the end of the table; the lattice arm 40 cm (16") long, which at its end carries the ball bearing and axle of suspension of the pantograph, is at its lower surface about 3/4 cm above the board so that the paper for the reduced drawing can be easily placed under the axis of rotation of the pantograph in order to quickly ascertain the right position of the copy and original. This is especially important for reductions on a large scale (1/5 to 1/20) in which the foot of the ordinary frame rests on the paper and renders it very difficult to shift and adjust the latter. The price of pantographs I, II IIIb provided with this frame and level for vertical adjustment of the axis of rotation and with slide box for keeping the frame is increased by . . . . . Fr.

18. g) The price of pantograph III provided with this frame (18f) instead of the ordinary frame without horizontal adjustment is increased by . . . . . Fr.

18. h) Price of the frame only, with level for vertical adjustment of the axis of rotation and with slide box . . . . . Fr.



Nos. 19—22 of the catalogue.

Pantograph, ***Type IV,*** of square, hard drawn, brass tubes, for reducing and enlarging. For all work where shrinkage of the paper need not be taken into consideration. The joints are taper steel axles 3 cm long closely fitting in metal sleeves. The latter are fixed and screwed in accurately bored holes in the bars. For the ratios 1/20, 1/12, 1/10, 1/8, 1/6, 1/5, 1/4, 1/3, 2/5, 1/2, 3/5, 2/3, 3/4, 4/5 **or any specially desired ratio.** Bars nickelled. Simple release and simple frame as in III. One tracing point, one pricking point and one pencil point, all finely polished and nickelled. Polished fir case with strong lock and handle.

19. Length of the bars **60** cm (24") . . . . . Fr.
20. „ „ „ „ **72** „ (28") . . . . . „
21. „ „ „ „ **84** „ (33") . . . . . „
22. „ „ „ „ **96** „ (38") . . . . . „

No.

Pantograph, ***Type V,*** with wooden bars for reducing and enlarging. The points, joints and sleeves are of the same construction as in IV and very accurate; the holes are bored true as in III and IV. The bars are made of dry pear wood, and do not easily expand if kept dry and protected from the sun. **No guarantee can be given for lasting accuracy of the wooden pantographs.** Ratios, release, points and case as for IV

23. Length of the bars **72** cm (28″) . . . . . Fr.

24. „ „ „ „ **96** „ (38″) . . . . . „

The cases of pantographs IV and V are shorter than those of I—III, as the centre bar 2 is placed in the case separately, which entails no additional work in taking out or putting back the instrument, as even in long cases the *instrument can only be placed in the box at the ratio* 1/2, so that the instrument has always to be set unless used at 1/2.

24. a) **Pantograph,** ***Type VI,*** for enlarging and reducing up to 1/50, same as type III with releasing device No. 15 a and frame Nr. 18 f; made in one length only of 96 cm (38″) . . . . . Fr.

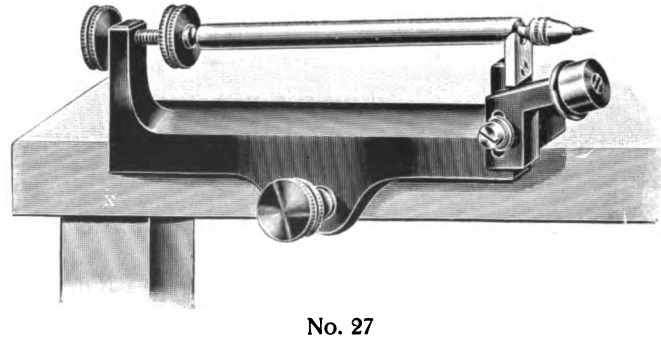
This pantograph is specially arranged for making reductions of plans up to 1 : 50 in the simplest manner and with the greatest accuracy. It is not necessary for this purpose to couple two pantographs, which method is troublesome, slow, expensive and liable to produce a number of errors.

25. Drawing pens for pantographs, making uniformly fine lines in all directions . . . . . each Fr.

26. Spare pricking points . . . . . „ „

26. a) Spare pencil tubes . . . . . „ „

27. **Apparatus,** for correct centrically pointing the pencils of pantographs; to screw on to table, with fine flat file . . . . . „



No. 27

My pantographs are without equal for accuracy and easy handling. The prices are extremely low; if similar instruments are offered by others at lower prices it is due to inferior workmanship.

Up to the present over 3500 of my pantographs have been sold; as references I can mention a large number of Public Authorities and engineers both at home and abroad.

A table of adjustment for various scales and ratios is supplied with each pantograph.

No.

27. a) **Beam compasses,** own construction, consisting of a hollow square brass bar of the same section as the bars of my pantographs; two adjustable sleeves, one with vernier and micrometer adjustment, the other with index only; interchangeable points, one needle, one pencil point and one drawing pen. The bar is graduated in millimeters, the vernier indicates $^1/_{10}$ mm. If the index of the one sleeve is set at the zero point of the graduation, the distance of both points corresponds with the measurement set at the vernier of the other sleeve. When using the instrument principally for short distances the bar can be placed more to the centre, by setting the index of the fixed sleeve at an even measurement (20 or 40 cm) [8" or 16"] and taking this measurement into consideration when tracing.
For 1 metre (40") span with case . . . . . Fr.

27. b) **same,** as No. 27 a) for a span of $1^1/_2$ metre (60") . . . . . „

Instructions for use accompany each planimeter.

B.
Planimeters.

Literature of reference:

F. Hohmann, Beschreibung, Theorie und Gebrauch des Präzisionspolarplanimeters, 1882.
Das freischwebende Präzisionsplanimeter, 1883.
Das Linear-Rollplanimeter, 1884.
By Th. Bloesings Universitäts-Buchhandlung, Erlangen.

G. Coradi, Das Präzisionsplanimeter, Patent Hohmann-Coradi,
Zeitschrift für Vermessungs-Wesen, 1881, page 127.

Ing. **F. H. Reitz,** Planimeter Hohmann-Coradi, Zeitschrift für Vermessungs-Wesen, 1882, page 523.

Prof. **F. Lorber,** Das freischwebende Präzisions-Polarplanimeter,
Zeitschrift für Vermessungs-Wesen, 1884, page 1.

Ing. **F. H. Reitz,** Rollplanimeter, Patent Hohmann-Coradi,
Zeitschrift für Vermessungs-Wesen, 1884, page 479.

Prof. **P. Fenner,** Beitrag zur Theorie des Rollplanimeters,
Zeitschrift für Vermessungs-Wesen, 1886, pages 216, 242, 560.

Prof. **J. J. Stambach,** Die Planimeter Coradi, ihre Theorie, Konstruktion und Genauigkeit,
Stuttgart, 1889, bei Konrad Wittwer.

Prof. **F. Lorber,** Coradi's Kugelplanimeter, Zeitschrift für Vermessungs-Wesen, 1888, page 161.

V. Lefrançois, Nouveau Planimètre de Précision, 1890,
by M. Boiton, Place Victor Hugo 9, Grenoble.

Vergl. Landmesser **O. Lang,** Kompensations-Polarplanimeter von G. Coradi,
Zeitschrift für Vermessungs-Wesen, 1894, page 553.

Vergl. Landmesser **O. Lang,** Neuerung an Kompensationsplanimetern,
Zeitschrift für Vermessungs-Wesen, 1898, page 147.

No.
28. **„The Coradi Planimeters“,** a pamphlet in German, French, English and Italian of 40 pages with 25 illustrations, price each . . . . . Fr.
(This amount will be refunded on ordering a planimeter).
All engineers having to measure areas and who possess a planimeter or intend to procure one, should peruse this useful pamphlet as it contains, in addition to a general easily understandable theory of planimeters, valuable hints and general rules for the practical use of these instruments, and explains the special qualities and advantages of planimeters of different construction. This pamphlet gives the results obtained by the author after many years' efforts to improve the planimeter.

28. a) If the planimeters are to be adjusted for *two* measures (metric and inch measure or metric and cordmeasure etc.) and also **when a large number of unusual scale ratios** are required, the price will be increased by . . . . . Fr.

1. Rolling sphere planimeter.

The instrument rests on the plan by two cylindrical rollers of equal size and can be moved forward in a straight line to any desired distance, causing the rotation of the rollers which impart motion to the axle of the sphere and the spherical segment thereon. The latter actuates the cylindrical measuring roller which remains parallel to the tracer arm and is provided with a graduated circle of celluloid; the measuring roller is pressed against the segment by means of a spring. The left end of the frame which carries the axle of the sphere can be raised by turning the excentric screw marked with an arrow, so that the small wheel on the axle of the sphere becomes disengaged and during the trial tracing of the figures the travelling roller only turns. The frame of the measuring roller is further provided with a set screw, to separate the cylinder from the sphere. In the frame *B* is a brake screw which acts on the roller *R* and enables the instrument to be fixed on the plan. The tracer has a turning winged handle with an adjustable elastic support. The tracer arm can describe an angle of 30°, left and right, **so that areas of any desired length and a width not exceeding the length of the adjusted tracer arm can be measured in one operation.**

The graduations on the measuring roller and counting wheel are on white celluloid, the measuring roller and the spherical segment are made of a hard nickel alloy and ground cylindrically or spherically true.

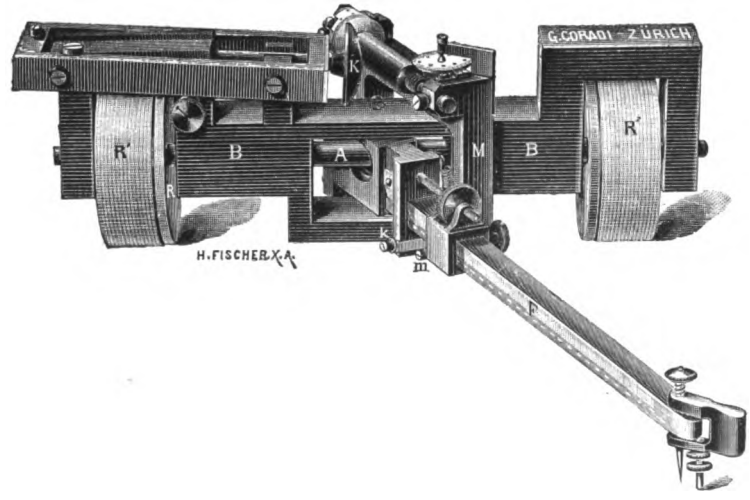
The cases are so arranged as to enable the tracer arm to remain in its position when the instrument is put in its case (extreme positions excepted). The larger cases from No. 29—34 have a strong lock and handle.

The large rolling planimeters No. 31 and 32 have proved the most perfect, accurate and best of all planimeters when carefully used on smooth plans.

Simple and easy setting up. Very large and long figures can be measured in one operation. Greatest possible accuracy on smooth plans.

No.

29. **Small rolling sphere Planimeter** (see figure below) for vernier units of 0,8 to 0,32 square mm (0,00125 square inch to 0,0005 square inch), length of roller 12 cm (4 1/2 "), tracer arm 20 cm (8 "). The counting wheel of celluloid indicates 50 revolutions of the roller. With testing rule and elegant locking case . . . . Fr.



Nos. 29—32 of the catalogue.

No.

30. **The same** with extension of the tracer arm up to 40 cm (16") for vernier units of 1,6 to 0,32 square mm (0,0025 square inch to 0,0005 square inch) . Fr.

31. **Large rolling sphere planimeter,** length of roller 16 cm ($6^1/_2$"), tracer arm 30 cm (12"), for vernier units of 1 to 0,4 square mm (0,0016 square inch to 0,0005 square inch), in other respects the same as No. 29, but larger. By reason of its weight this instrument can be used on old and shrunk plans almost as well as the disc planimeter. With testing rule and elegant locking case . . . . . Fr.

32. **The same** with extension of the tracer arm for vernier units of 2 to 0,4 square mm (0,003 square inch to 0,0005 square inch) . . . . . Fr.

The tracer arm extension cannot be supplied subsequently.

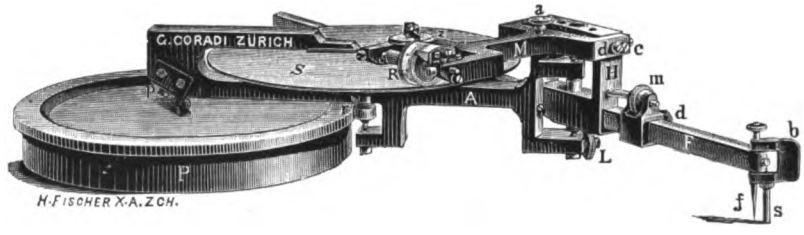
2. Precision disc polar planimeter.

Special advantages of the disc planimeter.

The movement of the measuring roller is perfectly independent of the nature of the plan; even on old, shrunk or rolled plans reliable measurements of area can be made. Maximum of accuracy. Easy reading. Easier manipulation than with all former instruments of this kind. Great durability.

The precision disc planimeter consists of two separate parts: the metal pole disc *P* and the planimeter properly. The latter is connected with the disc by simply placing the bearing *p* over the centre sphere of the pole disc and allowing the tracer *f* and the running roller *L* to rest on the plan. By moving the tracer round the pole the small wheel *r* which always engages in the toothed circumference of the pole disc and the disc *S* on the axle of the small wheel is caused to rotate. The disc *S* is of aluminium, ripped underneath and covered with paper on top. On the disc rests the measuring roller of chilled steel. Graduation and counting wheel as in the rolling planimeter. In the frame *M* of the measuring roller is a screw by which the measuring roller can be raised from the disc.

The frame folds so that the disc can be easily cleaned. At the bottom of the frame *M* is a spring to prevent the whole weight of the frame resting on the measuring roller; the tracer has a turning winged handle with support *s*, which can be so adjusted that the point of the tracer moves just clear of the paper; by means of a spring the support keeps the tracer so suspended that its point can at any time by pressed into the paper, whereby the tracing and accurate adjustment of the initial point is considerably facilitated, without preventing the use of a rule for tracing.



No. 33—34 a of the catalogue.

33. **Precision disc planimeter.** Diameter of pole disc 15 cm (6"), length of pole arm 17 cm ($5^3/_4$"), length of tracer arm 30 cm (12"), with micrometer adjustment, adjustable for values of the vernier unit from 2 square mm to 0,5 square mm (0,003 square inch to 0,0008 square inch). With testing rule and elegant locking case Fr.

No.

33. a) **The same** as No. 33 for two measures (for example metric and cord measure) . . . . . Fr.

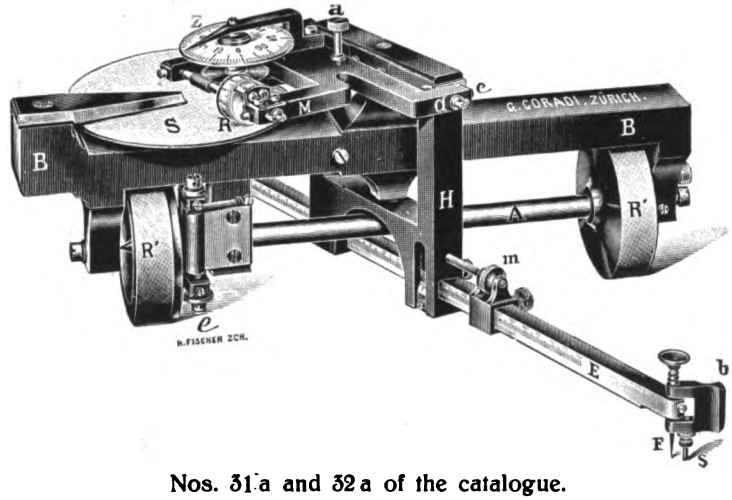
34. **The same** as No. 33 with determination of the constants for pole within the figure . . . . . „

34. a) **The same** as No. 34 for two measures (for example metric and cord measure) . . . . . „

34. b) **Counting wheel,** indicating up to 1000 revolutions of the measuring roller. The price of planimeters Nos. 29—34 a when provided with this counting wheel is increased by . . . . . Fr.

34. c) Planimeters No. 33 and 34 can be arranged so that the mean height of **Indicator diagrams** can be read directly. The tracer arm is graduated in $^1/_2$ mm; the vernier on this graduation indicates exactly the distance of the tracer point from the axis of rotation of the tracer arm, i. e. the length of the tracer arm, in $^1/_2$ mm. If the tracer arm is set to the same length as the base, the reading multiplied by 0,01 gives at once the mean height of the diagram in mm. Extra price . . . . . Fr.

3. Patent Rolling disc planimeter.



Nos. 31 a and 32 a of the catalogue.

The rolling disc planimeter was constructed in order to comply with an often expressed wish for a planimeter, as practical as the rolling sphere planimeter, but less intricate in the handling. In this planimeter which is a combination of the rolling sphere planimeter and the disc polar planimeter, the integration parts (sphere and cylinder) are replaced by somewhat less intricate parts (disc and roller). The maximum area that can be measured in one operation with the rolling disc planimeter is a rectangle at any desired length and a width not exceeding the length of the adjusted tracer arm.

The above illustration represents the instrument in about $^1/_3$rd of its actual size. The distance between the two rollers is 17 cm (6 $^3/_4$ "), so that diagrams of indicators

No.

(Wattmeters, steam-gauges etc.) up to a width of 17 cm (6 3/4") and any desired length can be measured without the rollers touching the paper. The aluminium disc *S*, which is covered with paper, is fixed on a vertical axis, which can be easily turned between two pivots; the small toothed wheel on the axis engages automatically, i. e. elastically, in the gearing of the roller *R*, so that no obstruction or deviation from the rectilinear travelling of the running roller is caused owing to dust or other extraneous matter which might get in between the gearing. This elastic contact is protected by a German patent. The measuring roller and its frame are similar to those of the disc polar planimeter; the gear wheel indicates up to 100 revolutions of the measuring roller. The tracer arm, its graduation, length and arrangement, the values of the vernier units of the measuring roller are the same as in the large rolling sphere planimeter. The handling is exactly the same as for that instrument.

31. a) **Rolling Disc Planimeter,** as described above. Length of the roller 20,5 cm (8"), distance between rollers 17 cm (6 3/4") length of tracer arm 30 cm (12"), with micrometer adjustment, adjustable for values of the vernier unit of 1 square mm to 0,4 square mm (0,0016 square inch to 0,0005 square inch). With testing rule and locking case . . . . . Fr.

This planimeter is particularly suitable for measuring long indicator diagrams with rectangular ordinates.

32. a) **Rolling Disc Planimeter,** as No. 31 a, but with extension of the tracer arm to be fitted on, adjustable for values of the vernier unit of 2 square mm to 0,4 square mm (0,0032 square inch to 0,0005 square inch). With testing rule and locking case Fr.

32. b) **Rolling Disc Planimeter with Measuring Roller-Guide.**

The point of contact of the measuring roller moves on a diameter of the disc *S*, in consequence of which the turning of the roller is effected by proper rolling without slipping.

The following illustration represents the instrument in about 1/3 of its actual size. The whole arrangement is similar to that in the large rolling sphere planimeter. The measuring roller with counting wheel, which indicates 100 revolutions of the former, is fixed on the carriage *W*, this latter is moved to and fro by means of the lever *C* on the sleeve *H* of the tracer arm, i. e. proportionately to the sine of the angle α formed by the tracer arm with the *X*-axis of the instrument.

When the tracer is on the *X*-axis, then the point of contact of the measuring roller is on the centre of the disc *S*; therefore, the turning of the measuring roller is always proportional to *sine* α.

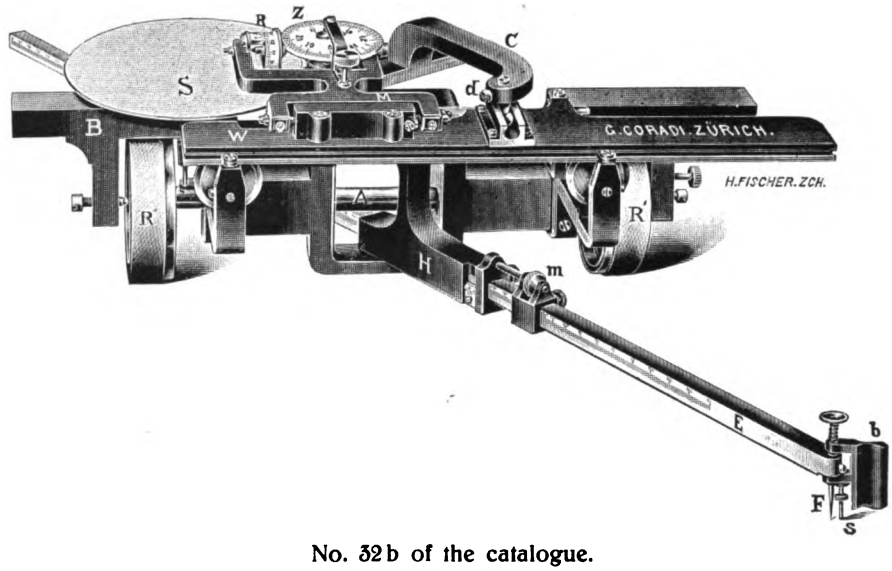
The lever *C* (*sine* lever) is connected with the tracer arm sleeve by means of a horizontal axle and carries at the front part a chilled steel ball which is pressed by the weight of the lever into the hollow-cylindrical guide-groove of the carriage *W*, so that the latter moves to and fro without the least back lash.

The aluminium disc *S*, which is covered with paper, is fixed on a vertical axle, the small toothed wheel of which engages in the gearing on the roller *R*, so that the

No.

revolutions of the disc are proportional to the line X which the roller RR' rolls through on the plan in a straight direction.

The bearing of the axis of the disc is so arranged that the contact of the small toothed wheel is, so to say, elastic, and so that no obstruction or deviation of the roller from its straight course is caused by dust or other foreign matter which might get in between the gearing.



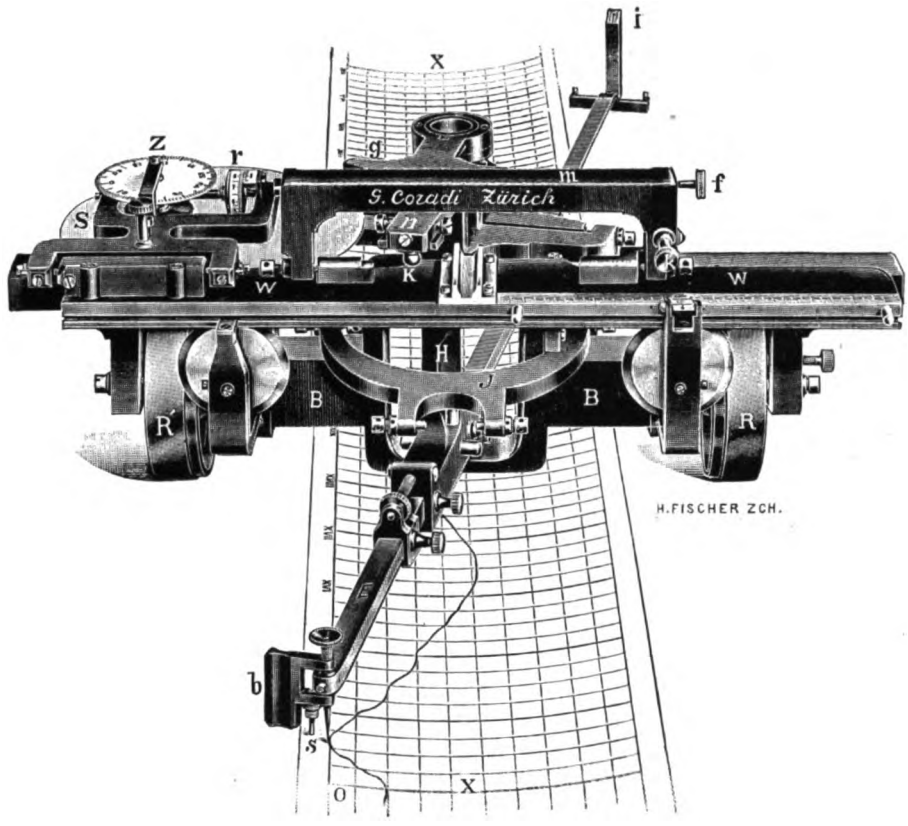
No. 32 b of the catalogue.

The tracer arm, which is 55 cm (22 ") long and allows an angle of 45°, left and right, of the X-axis, to be described, is provided with micrometer adjustment, graduation and vernier and can be adjusted for values of the vernier unit of 1 square mm to 2 square mm (0,0016 square inch to 0,0032 square inch).

Price with testing rule of 20 cm (8 ") length and locking case . . . . Fr.

NOTE: This planimeter was constructed in 1907 at the request of Mr. H. BASTONE, Chief of the Italian Survey Departement for measuring areas. When giving the order it was stipulated that for a value of the vernier unit of 2 square mm (0,003 square inch) it should be possible in one operation to trace a sheet of 70×100 cm (28"×40), the error not exceeding $^1/_{2000}$. On three subsequent occasions 2 instruments have been supplied which were improved according to the experience gained. Consequently the planimeter illustrated above is the most perfect instrument of its kind on the market.

32. c) **Rolling Disc Planimeter, for ordinary determination of areas and for determining the contents of diagram cards with arc ordinates and arc-like abscissae-distances.** i. e. for the two integrals $\int \sin e\, \alpha\, d\, x$ and $\int arc\, \alpha\, d\, x$. This planimeter was constructed by order of the *„Chemin de fer Metropolitain Paris"*. As regards size and arrangement it is similar to No. 32 b, but it is provided with a device which makes it possible either to move the carriage W and the measuring roller proportionally to *sine* α by means of the *sine* lever C, or to move the carriage proportionally to *arc* α by means of a toothed segment, centrically fixed on the rotating axle of the tracer



No. 32 c of the catalogue.

arm, which engages in a rack on the carriage *W*. When the segment is thrown into gear, the lever *C* is lifted out of the *sine* guide and consequently thrown out of gear.

When ordering an instrument the length of the writing lever of the indicator and the width of the diagram card must be stated.

Price with case . . . . . Fr.

4. Compensation Planimeters.

Special advantages of these polar-planimeters:

1. By two tracings of an area with the pole on the left and right of the tracer arm respectively, the error originating from an improper position of the axis of the measuring roller can be eliminated.

2. The ball joint forming the axis of rotation of the tracer arm can never become shaky; it is only necessary to see that the recess *D* in the sleeve of the tracer arm is kept clean.

3. As the instrument is put in the case in two separate parts, the joint of the pole arm, and tracer arm cannot get loose during transport.

4. As the tracer arm can describe an angle of nearly 180°, left and right of the pole arm, without departing from its normal position to the plane of the plan, larger areas can be measured in one operation than is possible with the former construction or with the ordinary Amsler plani-

No.

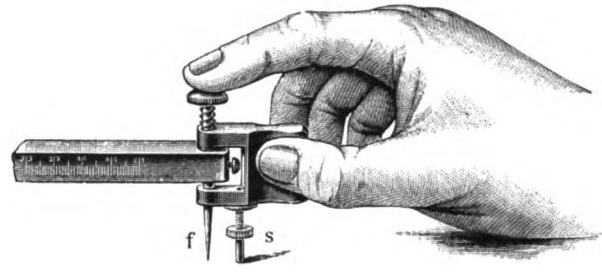
meter which at the utmost only have an angular movement of the tracer arm of about 90—100°.

5. In order to test the parallel position of the axis of the roller, areas of the size allowed by the tracer arm can be measured as each tracing on the left and right of the pole must furnish the same result.

6. The reading on the roller is perfectly unobstructed; the absence of the pole arm formerly suspended on the instrument enables the planimeter to be more easily handled.

7. The pole is so constructed as to combine the advantages of the weight-pole and the needle-pole, **the point need not be pressed into the paper;** by laterally inclining the pole arm and shifting the pole, the measuring roller can be quickly and safely set to zero, when the tracer is at the initial point of the tracing.

This device gives the instrument a perfectly safe position and the plan is not spoilt by pin pricks.



8. Close to the tracer is a turning winged handle with support, which can be so adjusted as to keep the point of the tracer just clear of the paper (see above illustration). The tracer point may therefore be very fine so that the outline of the drawing can be accurately traced. The support revolves round the tracer and does not prevent a rule being used for tracing. By slightly pressing with the forefinger on the knob of the tracer the point can at any time be pressed into the paper. All my planimeters are provided with this winged handle.

9. By means of the graduation of the tracer arm in $^1/_2$ mm (and that of the vernier in $^1/_{20}$ mm) any ratios can be easily set and noted in the table fixed in the case; the graduation can also allow for shrinkage of paper.

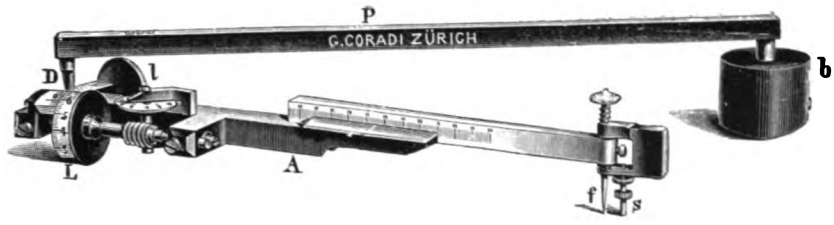
10. These planimeters can be placed in the case when set to any scale.

11. The accuracy of the instrument is guaranteed. Each planimeter is furnished with a testing rule provided with a needle centre and 4 respectively 3 recessed points exactly 2 cm (or 1") apart and an index (see figure No. 39).

12. The roller graduations are exactly indicated on white celluloid and are very fine so that even fractions of a vernier unit can be estimated.

13. The measuring roller consists of a disc of **chilled steel** strongly connected with the axle, which is considerably less liable to rust and wear than soft steel.

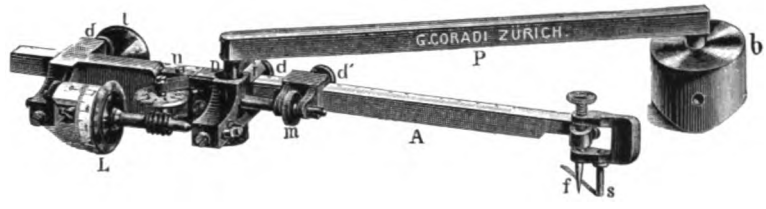
35. (I) **Compensation Planimeter** adjusted for one vernier unit *only* between 8 and 10 square mm (0,016, 0,015 square inch or 0,01 square inch) as desired; length of pole arm 19 cm ($7^1/_2$"), length of tracer arm 16 cm ($6^1/_2$"); the adjustable piece carrying the tracer is made of nickelled brass and is screwed on the tracer arm from underneath; it has a graduation in $^1/_2$ mm, on which an index mark indicates the length of the tracer arm. Roller of chilled steel, graduation of the roller and counting wheel on celluloid, convenient winged handle with support; testing rule with two points for 8 and 4 cm (3" and 2") radius and elegant case . . . . . Fr.



No. 35. (I)

35. E) **Compensating Planimeter** as No. 35 (I) but for the vernier unit 0,02 square inch. The tracer arm is longer and the diameter of the measuring roller larger. Larger areas can be measured, the reading is easier than in No. 35 as also the factor by which the result is multiplied . . . . . Fr.

36. (II) **Compensation-Planimeter** with graduated tracer arm provided with vernier and micrometer adjustment, adjustable for values of the vernier unit of 10 to 2 square mm

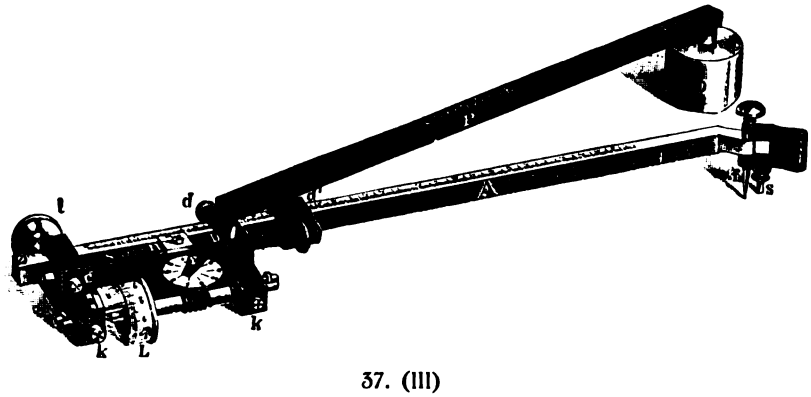


36. (II)

(0,016 square inch to 0,005 square inch) adjusted for 4 to 6 vernier units or settings of the tracer arm. Measuring roller and counting wheel as for No. I. Table in case shewing the values of the vernier unit, settings of tracer arm and constants, pole arm 19 cm (7 1/2 ") long, convenient winged handle and support, testing rule with 4 respectively 3 points for radii of 2, 4, 6 and 8 cm (1", 2" and 3") and elegant case Fr.

(In No. I and II the axis of the roller is once and for all placed parallel to the tracer arm so that no adjustment is provided or required).

*37.(III) **The same** as No. 36, but with easier adjustment for placing the axis of the roller and tracer arm parallel . . . . . Fr.

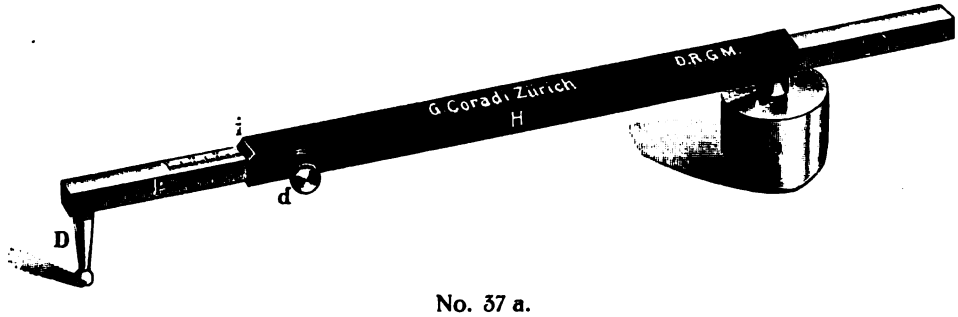


37. (III)

In No. 32, page 60, of the „Mitteilungen aus der Verwaltung der direkten Steuern", edited by the Prussian Ministry of Finance, it is stated in regard to this planimeter: The instrument will probably in the course of time entirely supersede all other polar-planimeters"

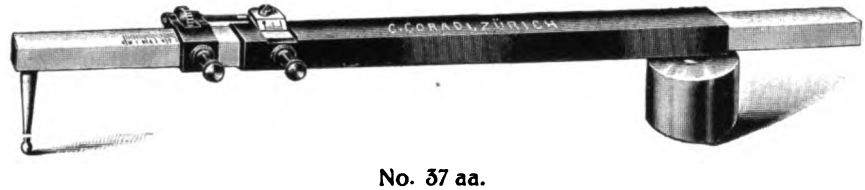
No.

37. a) **Planimeters No. 35, 35E, 36 and 37** can, instead of having a simple pole arm, be supplied with an **adjustable pole arm,** the length of which can be varied between 13 and 23 cm (5" and 9") and provided with one, two or three setting marks. If the pole arm is set to one of these marks by means of the facet *i*, the constant for „pole within" for the corresponding setting of the tracer arm is a round figure (20,000); the results are then absolutely the same for „pole within" and „pole without". — The setting on the pole arm for the constant 20,000 is indicated in the table in the case. Extra price of the planimeter with this pole arm . . . . Fr.



No. 37 a.

37. aa) **If the adjustable pole arm is provided with vernier and micrometer** adjustment the price of planimeters No. 35, 36 and 37 well be increased by . . . . . Fr.



No. 37 aa.

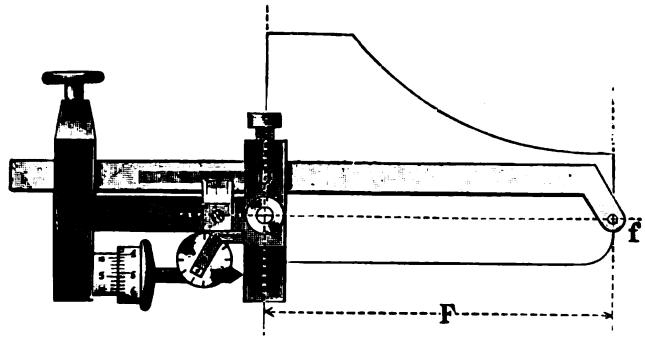
37. b) **Adjustable pole arm only,** without the three marks (see figure 37 a) Fr.

37. bb) **Adjustable pole arm only with micrometer adjustment and vernier,** but without the three marks (see figure 37 aa) . . . . . Fr.

(Pole arms cannot be exchanged)

37. c) **Planimeters No. 36. and 37 can be so arranged as to give at sight the mean height** of indicator diagrams. In this case the length of the tracer arm must be set equal to the length of the base of the diagram; this can either be done by means of the graduation on the tracer arm, the vernier of which exactly indicates in $^1/_2$ mm the length of the tracer arm (distance of the joint of the pole arm from the point of the tracer) or by setting the point of the tracer to one end of the tracer and moving the sleeve until the other end of the base (the pole arm being removed) appears in the centre of the small hole in the ball bearing of the pole (see figure page 23). The roller is exactly adjusted to 60 mm circumference. The result of the tracing multiplied by 0,6 will then give the mean height of the diagramm in mm.

Extra price of planimeters No. 36 and 37 . . . . . Fr.



For English measurements the circumference of the roller is 2'/₂" the result must then be multiplied by 0,0025 in order to obtain the mean height of the diagram in inches.

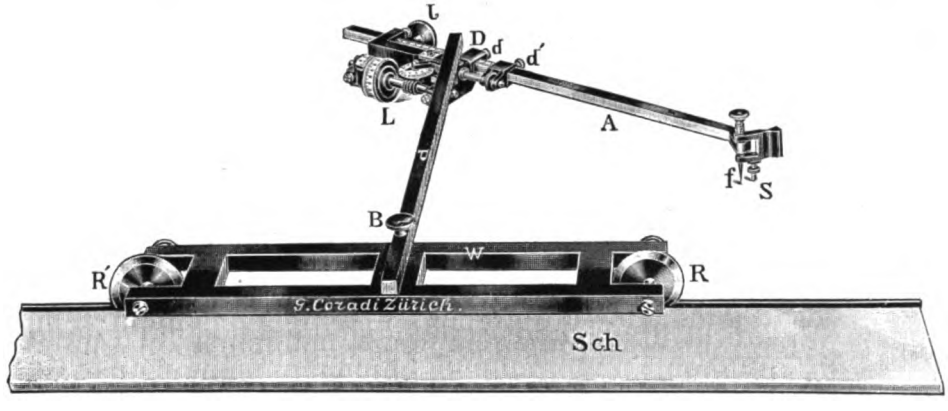
No.

37. d) **Carriage planimeter,** especially adapted for measuring areas on ships'plans. The instrument consists of a carriage connected as a pole arm with a compensation planimeter No. 35, 36 or 37 and of a steel rule with a groove in which the carriage with the planimeter can be moved (see figure).

Price of the carriage with connecting arm and case . . . . . Fr.

37. dL Price of the rule and case for the carriage and rule 150 cm (60 ') long „

37. dL2 do. 200 cm (80 ") long . . . . . Fr.



No. 37 d

Supplied to the following shipyards: Sachsenberg Bros., Roslau, Schichau of Elbing, Klawitter of Danzig, Germania Shipyard of Kiel etc.

5. Rule Planimeters with Compensation in one Tracing and with artificial surface of rotation for the Measuring Roller.

This type of planimeter was constructed in the year 1904 for the purpose of determining the areas of tanned hides and skins and has subsequently proved to be of excellent value (Patent No. 172789).

The various advantages of this instrument induced us to arrange it also for measuring traced figures. As the following illustration shows, these planimeters have no pole arm. The tracer arm carries at the front the tracer point and at the other end the spherical axis of rotation which

No.

is of chilled steel. This sphere can be moved in the corresponding groove of a steel rule, thus causing the measuring roller to rotate on the paper-covered surface of the steel rule. The measuring roller is so arranged that its plane plane extends through the axis of rotation of the tracer arm; consequently the angular motion of the tracer arm does not produce any turnings of the measuring roller.

These planimeters possess the following advantages:

1. The revolutions of the measuring roller do not depend upon the quality of the paper on which the figures to be determined are traced, as the measuring roller moves on a plane which always remains level, i. e. the steel rule covered with paper.

2. Long figures (diagram cards), according to the length of the rule, can be accurately, very easily and quickly measured and the results of each card added up.

3. Figures at the edge of the plan can be very easily measured and it need not to ascertain the position in which the roller does not go beyond the edge of the plan.

Figures (transverse sections etc), which are traced for instance for calculating prices on small sheets of paper and for reduced drawings, can likewise be easily measured.

4. By tracing a figure once the error of the roller inclination can be compensated:

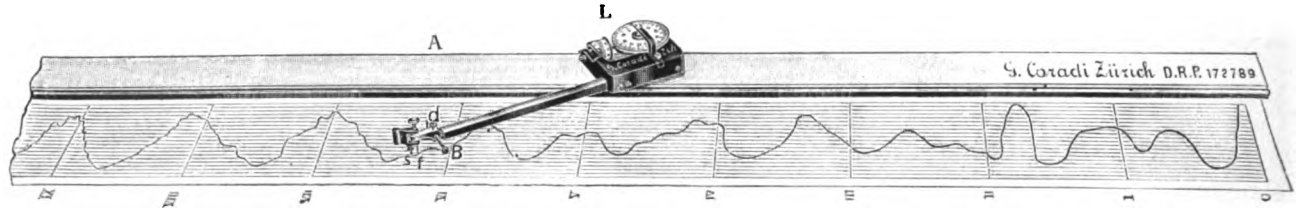
Because, if the area to be measured is placed in such a position in front of the rule that it is divided into two approximately equal areas by an imaginary extension of the groove of the rule (the centre line of which here represents the X-axis of the instrument, see figure 37 k) then the error which is produced in consequence of the position of the axis of the measuring roller not being perfectly parallel to the tracer arm, is compensated, as shown in the following example: Let α be the angle which is formed by the tracer arm with the X-axis, and $\pm \delta$ the angle which is formed by the axis of the measuring roller with the tracer arm; if the turning u of the measuring roller to the **left** of the X-axis =

$u = x \; sine\,(\alpha + \delta)$ then this turning to the **right** of the X-axis is

$u = x \; sine\,(\alpha - \delta)$ (or vice versa),

from which it results, that the error is compensated when the parts of the area on both sides of the X-axis are equally large, as δ is once positive and once negative. As δ is naturally only very small, it does not matter if the parts of the area to the left and the right of the X-axis are not exactly equal; it is therefore only necessary to fix the position of the X-axis approximately by sight in order to obtain a result in which compensation is made for the influence of the inclined position of the measuring roller.

Of these planimeters the following sorts are supplied:



No. 37 e

37. e) **Rule Planimeter,** as described above, specially arranged for measuring the surface area of long indicator-curves (see figure No. 37 e). The tracer arm is 32 cm (13") long and **fixed** for a value of the vernier unit of 20 square mm (0,03 square inches). The counting wheel indicates up to 100 revolutions of the measuring roller. Close to the tracer point a movable pin B is fixed, which can be so adjusted that the point of the tracer is at zero of the diagram when the pin and the card touch the

No.

edge of the steel rule. This line can therefore be quickly traced without it being necessary to observe the point of the tracer. This line must be traced to the last ordinate of the curve, which can be reached by the rule, the ordinate itself must be traced and then, returning to the initial point, the diagram curve and the initial ordinate.

When the initial point has been reached, the planimeter can be fixed in its final position by means of a forked pin set on the edge of the rule and the point of the tracer is lifted from the paper; the card can then be shifted so that the point of the tracer rests on the end ordinate for the tracing of the next part of the diagram and in this way the content of the separte parts of the diagram can be added up.

Maximum traceable area in front of the rule 300×260 mm (12"×10½"), maximum width at the side of the rule 240 mm (9½").

Price with case, but without rule . . . . . Fr.

37. e 1) Rule with small box 150 cm (60") long . . . . . „

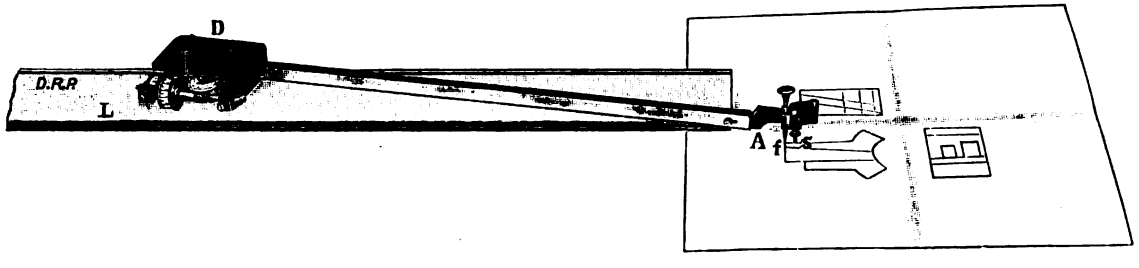
37. e 2) „ „ „ „ 200 „ (80") „ . . . . . „

longer rules according to agreement.

37. f) **The same,** as No. 37 e, but with tracer arm for 10 square mm (0,016 square inch) vernier unit . . . . . Fr.

37. g) **Rule Planimeter,** with fixed tracer arm for 10 square mm (0,016 square inch) vernier unit; counting wheel indicating 10 revolutions of the measuring roller, maximum traceable with at side of the rule 120 mm (4¾") maximum traceable area in front of the rule 170×90 mm (6¾×3½").

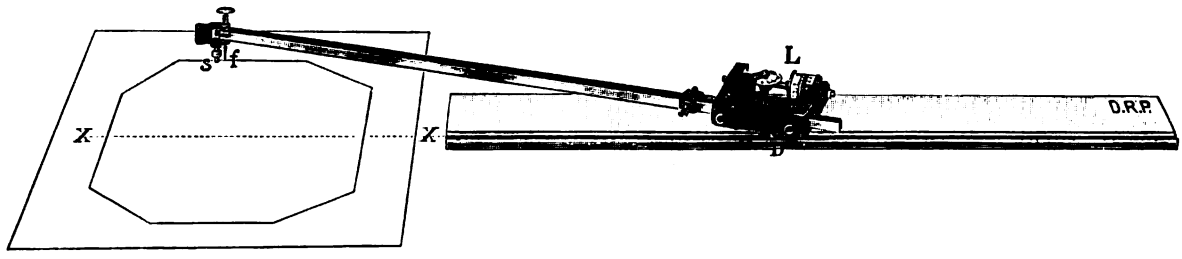
Price with rule of 24 cm (9½") length with case for the planimeter and box for the rule . . . . . Fr.



No. 37 h

37. h) **The same** as 37 g, but with tracer arm und rule of double the length, for vernier unit of 20 square mm (0,03 square inch) . . . . . Fr.

37. i) **The same** as 37 g, but with adjustable tracer arm, vernier and micrometer adjustment for values of the vernier units of 10—4 square mm (0,016—0,005 square inch) Fr.



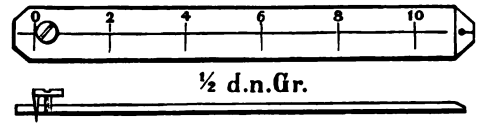
No. 37 k

No.

37. k) **The same** as 37 i, but with tracer arm and rule of double the length, for values of the vernier units of 20—5 square mm (0,03—0,01 square inch). . . . Fr.

Planimeters for special purposes are made to order at prices to be agreed upon.

38. **Testing Rule,** 8 cm (3") long . . . . . Fr.



No. 39

39. **Testing Rule,** 10 cm (4") long . . . . . Fr.

39. a) **Precision Testing Rule** for pole within and without. The rule turns round a metal point fixed in the paper by points, on the fixed disc of which pivot the needle pole of the compensation planimeter can be placed. 13 cm (5") long . Fr.

39. b) **The same,** 20 cm (8") long . . . . . „

40. **Testing Disc,** nickelled, round brass plate with engraved circles of 6 cm, 5 cm, 4 cm 2 cm (2½", 2" and 1") radius and two points for fixing on the paper. Fr.

C.

Integraphs.

Abdank-Abakanowicz System. — Coradi Construction.

Literature of reference:

Br. Abdank-Abakanowicz, „Les Integraphes" at Gauthier-Villars, Paris 1886.

Br. Abdank-Abakanowicz, German Edition by Emil Bitterli, „Die Integraphen, die Integralkurve und ihre Anwendung", at G. B. Teubner, Leipzig 1889.

Prof. Dr. **E. Hammer,** „Zeitschrift für Instrumentenkunde", Volume XXIV 1904, Page 213 and following.

Oberleutnant **Schatte,** „Kriegstechnische Zeitschrift", No. 8 and 9, 1909.

Dottore **C. Burali-Forti e Tenente E. Scalfaro,** professori, titolare ed aggiunto, di Geometria Analitico-Proiettiva R. Accademia Militare, L'integrafo di Abdank-Abakanowicz. Descrizione ed Uso. at the Torino Tip. e Lit. Societá Editrice Politecnica 1906.

The Uses of the Integraph in Ship Calculations, by John G. Johnstone, Esq. B. Sc. Glasgow: William Osher, 164 Howard Street 1904.

On the Application of the Integraph to Some Ship Calculations, by J. G Johnstone, esq., B. Sc. Accociate-Membre. Read at the Spring Meetings of the Forty-eighth Session of the Institute of Naval Architects, in the Chair. March 22. 1907.

Henry Lossier, „Der Integraph Abdank-Abakanowicz" (German and French), at G. Coradi, Zürich 1911.

The Integraph is an integrator which not only indicates the **final result** of the integration, but also gives a graphic representation thereof; whilst the tracer travels round the outline of the figure, the integraph automatically draws a curve (integral curve) the ordinates of which are proportionate to the area of the figure travelled around: $y' = \int y dx$. If this **first integral curve** is traced by the tracer of the integraph as a differential curve, the integraph draws a **second integral curve** the ordinates of which are proportional to the static moment: $y'' = \int y^2 dx$. By tracing this second integral curve we obtain a **third integral curve,** the ordinates of which are proportional to the moment of inertia: $y''' = \int y^3 dx$ etc.

The y-axis for the moments can be chosen anywhere on the curve, i. e. it can be shifted.

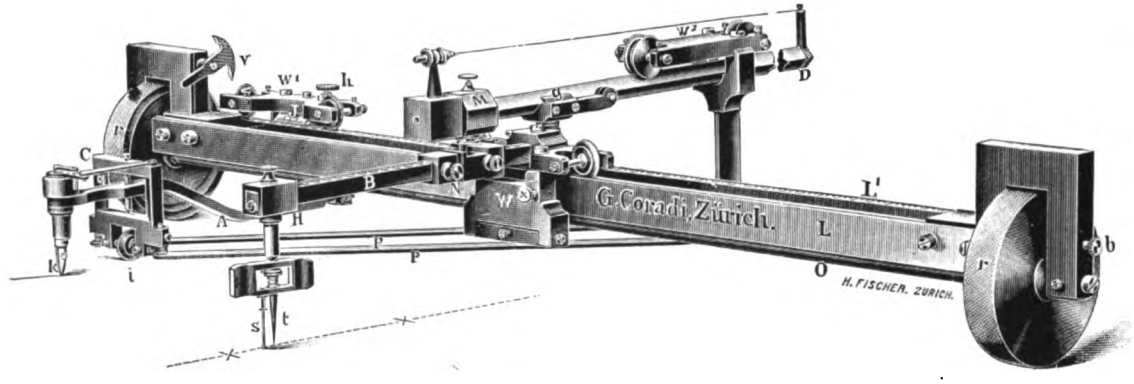
By means of the integraph many of the most difficult calculations and problems occurring in the practice of an engineer in shipbuilding, bridge and iron constructions, earth transports, electrotechnics, technical optics and ballistics can be solved in a simple and reliable manner with much saving of time and the operator need not posses any knowledge of higher mathematics.

The applications of the integraph are very numerous. With it we calculate areas, divide areas, determine centres of gravity, calculate moments of stability, load and resistance, solve algebraical equations, draw parabolas etc. See the treatise of the inventor B. Abdank-Abakanowicz: „Die Integralkurve, der Integraph und dessen Anwendungen", German edition by E. Bitterli, published by B. G. Teubner, Leipzig. A pamphlet published by me contains a description of the integraph, and a theory and a number of examples of the application of the same by Henry Lossier, Lecturer of Lausanne (in German and French), which will be sent on demand.

No.

41. **Integraph,** latest construction, large model (see figure 41). The whole apparatus rests on 3 points, the two rollers *rr* fixed to an axle *O* and the tracer *t*; it can be moved in the *X*-direction in a straight line over distances of any length. The guide carriage *W* and the integrating carriage W^1 have a lateral movement of 52 cm (21") in the *Y*-direction. The base (corresponding to the tracer arm in the planimeter) can be varied between 20 cm and 5 cm (8" and 2 1/2"). The base rule has a graduation in 1/2 mm (or 1/10") and vernier for 1/20 mm (or 1/100") and is provided with micrometer adjustment. The integrating carriage W^1 has a vernier for 1/10 mm (or 1/50") by means of which the final result can be read on the rule L^1 which is graduated in mm or 1/10" in the same way as in the planimeters.

Price with all accessories and case . . . . . Fr.



No. 41

41. a) **Integraph** as No. 41 and 42 a, but with longer frame and longer direction rule so that both carriages can travel 75 cm (30"). The direction rule is stiffened by 3 steel wires. Price . . . . . Fr.

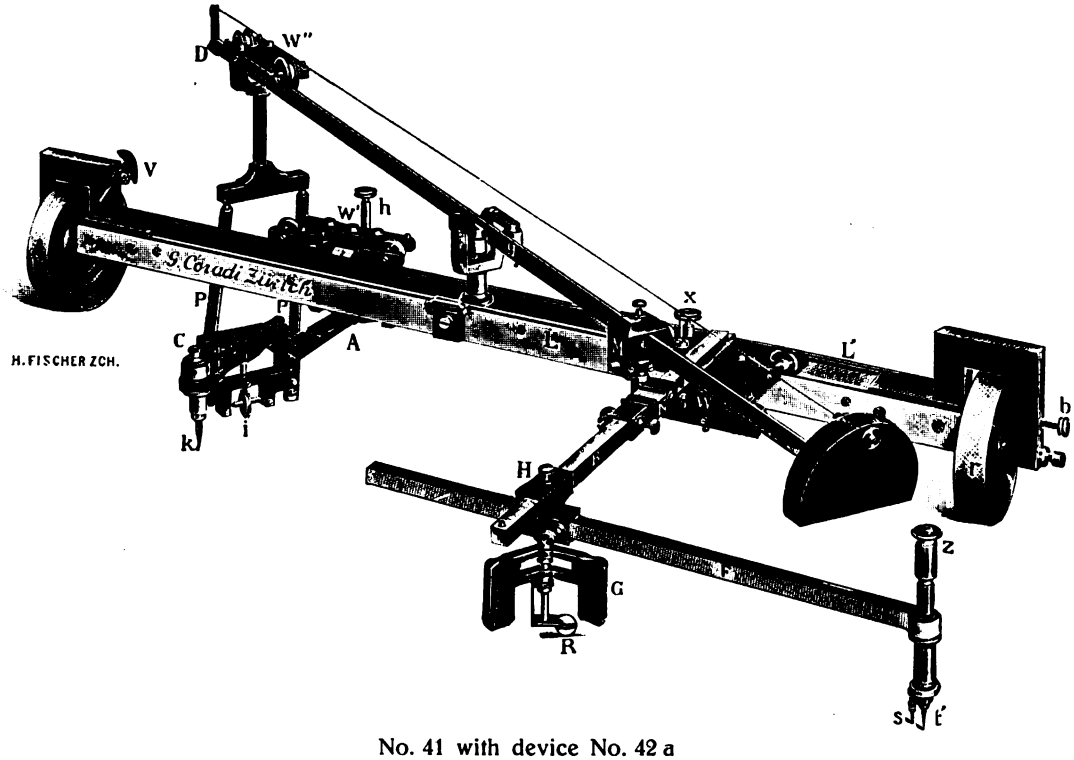
42. **Integraph,** small model. The guide- and integrating carriages have a lateral motion of 27 cm (10 3/4"); the base can be varied between 12 1/2 and 4 cm (5" and 1 1/2"). In all other respects similar to the large integraph No. 41.

Price with case . . . . . Fr.

42. a) **Device for moving the tracer point laterally** so as to adjust it easily on the *X*-axis of the figure without moving the whole instrument on the plan and readjust it in the *X*-direction. This device consists of a sleeve with cross-sleeve which can be moved on the base rule; a square, hollow, brass rod, which carries the tracer point sleeve *Z* and the tracer point, can be adjusted and fixed rectangularly to the base rule in the cross sleeve. At the place of the tracer point *t* (see figure No. 41, page 28) there is a running roller *R* with guide handle *G* which serves for guiding the whole apparatus (compare the following figure No. 41 with device No. 42 a) which shows an integraph

No.

of the latest construction **with** the said device No. 42 a). The arm *F* can be taken out and the tracer point if required fixed also on the left side of the base.
Extra price . . . . . Fr.



No. 41 with device No. 42 a

42. b) If on the arm *F* (figure 41 with device 42 a) at the place of the tracer point, a sleeve is fixed in which an arm carrying the tracer point can be adjusted in the *X*-direction in order to enable the tracer point and the drawing pen to be placed on the same ordinates, the price will be increased by . . . . . Fr.

42. c) **Device for fixing the Guide Carriage** in any desired position and adjusting it, by means of a fine screw, at a certain distance from the *X*-axis . . Fr.

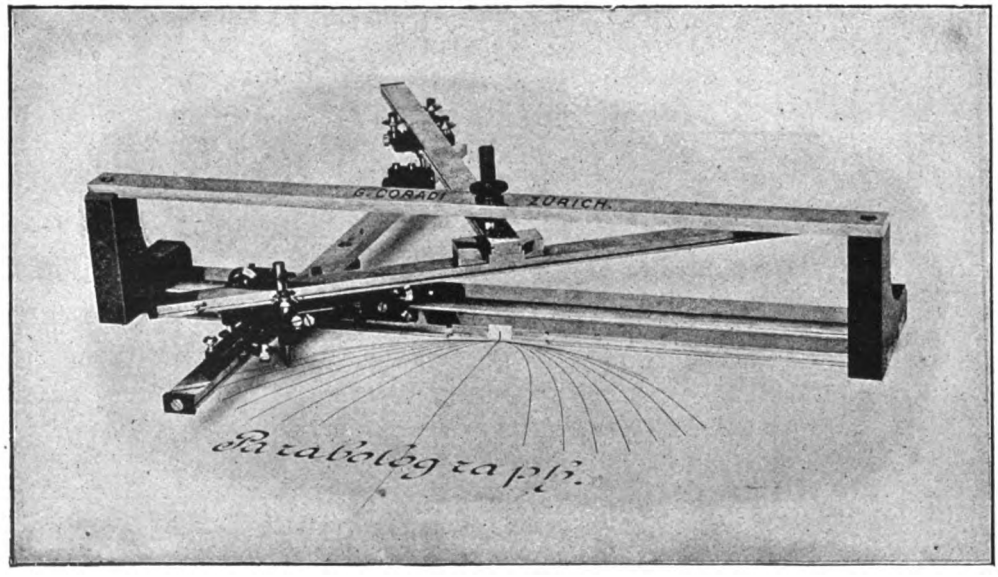
42. d) **Device for differentiating,** consisting of a cylindrical pin, which fits into the sleeve of the drawing pen and carries a glass plate with engraved cross lines which rests on of the plan; these cross lines must be parallel to the *X*-respectively the *Y*-direction when the guide carriage *W* is in its normal position. The pin fitting in the sleeve of the drawing pen is connected with the frame of the integrating roller by means of a parallellogram, so that when moving the guide carriage one of the cross lines is always parallel to the plane of the integrating roller respectively to the direction rule. If a curve is to be differentiated, the cross line is placed so on the curve by means of the guide carriage, that the cross line parallel to the direction rule is always parallel to the elements of the curve in question . . . . . Fr.

No.

42. e) **Device for differentiating** as described above but having instead of the cross lines a reflector resting vertically on the plan; this must always be rectangular to the *X*-line when the guide carriage is in its normal position, a proof of which is that the reflection of the *X*-line forms a straight (uninterrupted) continuation of the same. If a curve is to be differentiated the mirror is placed so on the curve by means of the guide carriage *W* that the reflection forms an uninterrupted continuation of the elements of the curve in question. The differential curve is however not traced by means of a continuous line but by making dots at suitable distances with the tracer point of the guide carriage and afterwards connecting these by hand with a pencil. Price . . . . Fr.

43. **Parabolograph** Payne-Coradi, by Professor Payne, Melbourne, Australia.

This apparatus is adjusted, by means of an index on the base plate, on the axis of the parabola to be traced, and the edge of the base plate on the tangent of the vertical point.



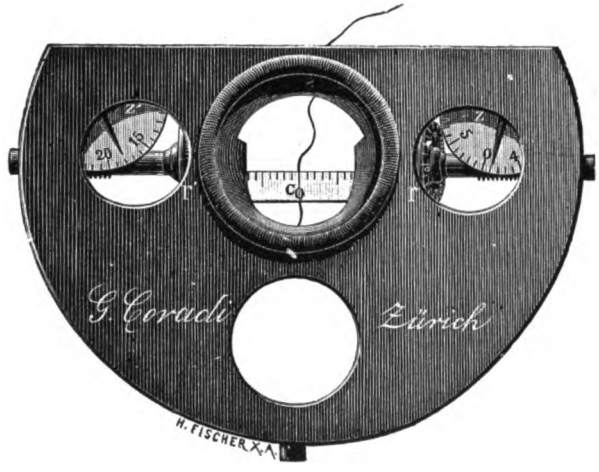
No. 43

By means of a slide on the parallel rule the apparatus can be so adjusted that the parabola traced by the drawing pen traverses a certain point to the left or right of the axis.

Price with polished pine case . . . . . Fr.

No.

44. **Curvimeter** of special construction for measuring horizontal lengths on maps and plans. The axes of the two measuring rollers and the guide point *c* lie in one line and the edges of the two rollers, with which the instrument rests on the plan, are exactly equi-distant from the point *c*. The circumference of each roller is 40 mm and is divided into 20 parts and numbered twice from 0--9 so that the sum of the readings of both rollers give whole millimeters. Both rollers are numbered in the same direction so that on turning the instrument round the point *c*, without moving it forward, the sum of both turnings = zero; if the instrument is moved forward in a straight line each of the rollers shews half of the distance traversed by *c*. If we trace



No. 44

any given curve by placing the axes of the rollers perpendicularly to the elements of the curve (a deviation of 8° from the perpendicular produces a difference of $^1/_{100}$ only) the sum of both readings will shew the distance traversed by the point *c*. As regards accuracy this curvimeter exceeds all others. In experiments *I* obtained for straight lines an accuracy of about $^1/_{2000}$.

Price with case . . . . . Fr.

44. a) **The same for English** measurements, Circumference of roller 2 ", graduated $^1/_{100}$ inch Fr.

D.

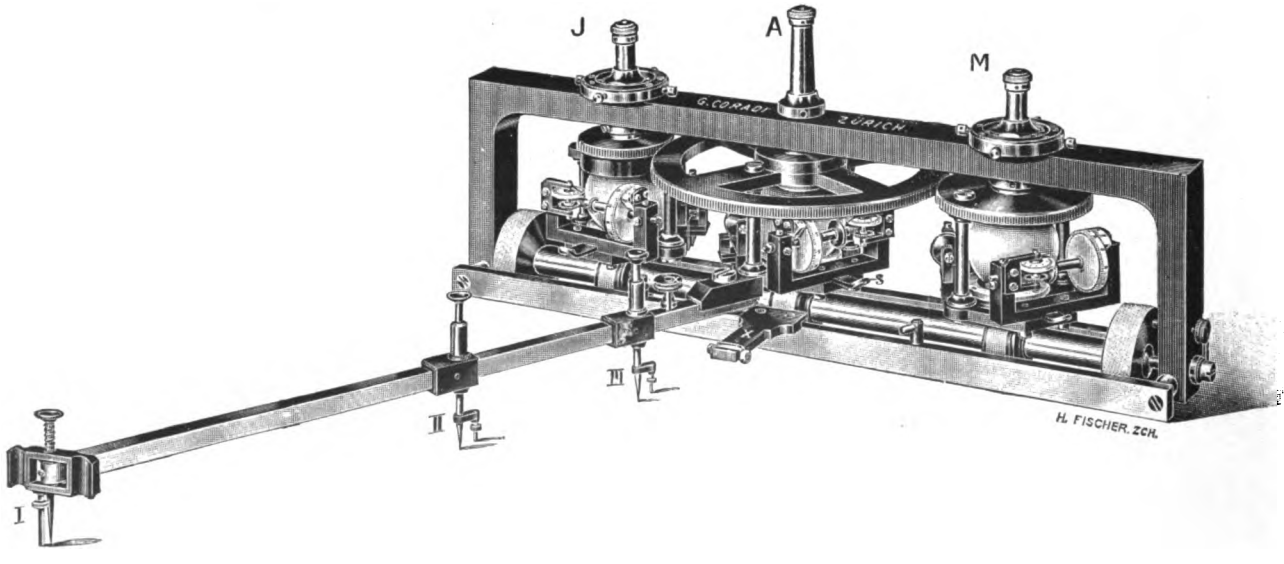
Integrators. (Moment planimeters).

Special construction, designed by Prof. H. S. Hele-Shaw of Liverpool.

The instrument can be moved in a straight line by means of a running roller of 35 cm length (14"), as my rolling planimeter, to any desired distance on the plan. On the shaft of the travelling roller 3 cylinders of celluloid are fixed, each of which carries an opaque glass sphere; to these glass spheres the movement of the travelling roller is imparted. The glass spheres impart motion to the measuring rollers which are so placed in the frame of the spheres, that they always touch these latter. Each of these frames turns on a vertical axle and are so connected by means of gear wheels that when the tracer arm forms with the X-axis the angle α, the axis of the roller which measures the area (centre) remains parallel to the tracer arm, and the axis of the roller calculating the moment of stability (right) forms the angle $90^0 \pm 2\alpha$ with the X-axis whilst the axis of the roller measuring the moment of inertia (left) forms the angle 3α with the X-axis. This arrangement prevents any slipping of the measuring rollers.

The new integrator, above described, possesses the **following special advantages** as compared with the usual integrators:

1. The measuring rollers do not move on the plan itself but on opaque glass spheres ground mathematically true; their movements are therefore not affected by unevenness and creases in the paper for which reason more accurate results are obtained.
2. The measuring roller makes no slipping movement, but exclusively pure rolling movements; the former movements are the main source of error with other integrators and for this reason the result obtained from the new instrument will be more accurate and reliable.
3. The angular movement of the tracer arm involves no movement of the measuring rollers: the error of setting to the initial point of the tracing is therefore entirely avoided.
4. The diameter of the graduation of the measuring rollers is greater than with other instruments and consequently more accurate and convenient readings can be taken.
5. The instrument allows of tracing figures of any desired length.



No.

45. **Integrator** (see figure page 32). By tracing the figure once the area and the moments of stability and inertia of the figure are obtained, both these latter on the basis of any desired axis. The tracer arm is provided with a fixed tracer at a distance of 400 mm (16 ") from the axis of rotation of the tracer arm and with two free falling tracers at a distance of 200 and 100 mm (8 " and 4 "). The tracer arm allows of an angular movement of about 60° to the left and right of the *X*-axis. Consequently it is possible with the extreme tracer to trace areas of 50 cm (20 ") width and any desired length in one operation. The graduated circles of the measuring rollers of 30 mm ($1^1/_4$ ") diameter are of white celluloid as also the counting discs which indicate up to 50 revolutions of the measuring rollers.

Price with case . . . . . Fr.

46. **The same Instrument as No. 45,** but with only one fixed tracer at a distance of 200 mm (8 ") and one free falling tracer at a distance of 100 mm (4 ") Fr.

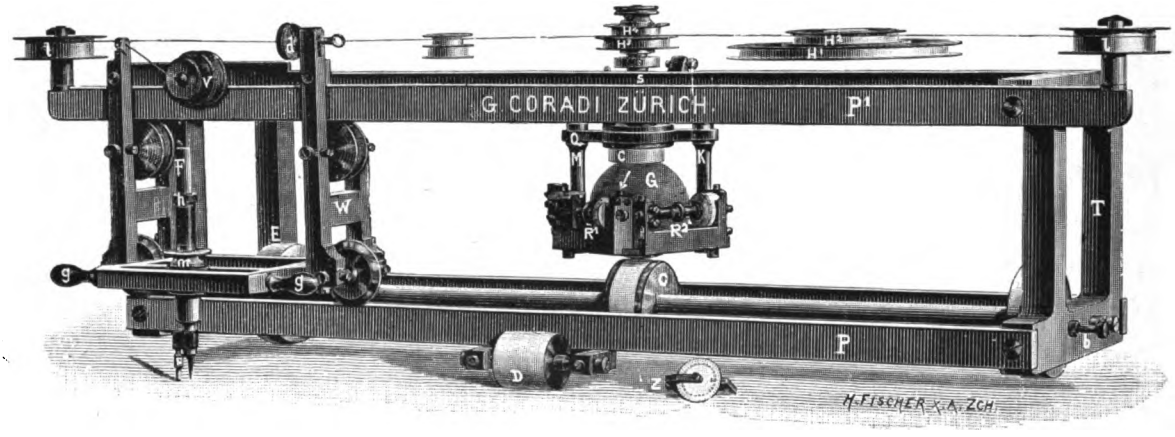
47. **The same instrument as No. 45,** but with two integrating apparati only, either for area and moment of stability or for area and moment of inertia . . Fr.

NB. When ordering it should be stated wheter the instrument is to be arranged for English or metric measurement.

E.

Harmonic analyzers.

As designed hy Prof. O. Henrici of London.



No. 48

No.

These instruments are intended for calculating the amplitudes and phases of continuous curves such as diagrams of recording barometers and thermometers, self-registering water gauges, power-diagrams of dynamos and steam engines etc. etc. The measuring rollers of an integrating apparatus give the coefficients A and B of the Fourier Series by means of which any continuous curve can be converted into a sine and cosine curve. A description, either in German or French, containing the theory and instructions for use, will be sent on application.

48. **Analyzer** with 360 mm base and **one integrating apparatus** only, on the left and right a guide roller moving between needle points on the large frame; counting wheels indicating up to 50 revolutions of the roller. On the vertical axle **a three step pulley** in order to determine the different elements of a curve up to $\mathbf{n} = 3$ by triple tracing. Lifting device for the glass sphere. Case with dusting brush, screw driver and pin and spool of silver wire . . . . . Fr.

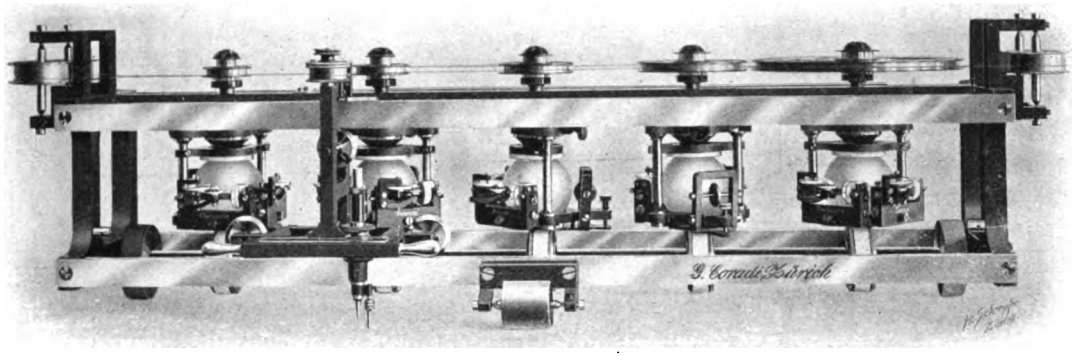
48. a) **For each extra three-step pulley** (not more than two can be used) Fr.

49. **Analyzer** with base of 360 or 400 mm with **three integrating apparati.** Double counting wheels indicating up to 400 revolutions. 4 travelling rollers, two on the left and two on the right, fixed on the frame and moving between needle points

No.

in order to tighten the wire for the top and bottom pulleys as far as possible in a straight line; on each vertical axis a step pulley with **two** steps in order to determine the different elements of a curve up to $\mathbf{n} = 6$ by double tracing. Accessories and case as for No. 48 . . . . . Fr.

49. a) **Analyzer** as No. 49, but with one step pulley with **three** steps on each vertical axis in order to determine the different elements of a curve up to $\mathbf{n} = 9$ by triple tracing. Fr.



No. 50

50. **Analyzer** as No. 49 (see the above illustration) but with integrating apparati and **five** double **pulleys** in order to determine the elements of a curve up to $\mathbf{n} = 10$ by double tracing.

Only for 400 mm base . . . . . Fr.

Analyzers have been supplied to the following institutes:

Guilds Central Technical College, London (No. 50).
Guilds Technical College, Finsbury, London (No. 48).
South Kensington Museum, London (No. 49).
Imperial Astronomical Observatory, Moscow (No. 50).
Physical Institute of the Zurich Polytechnikum (No. 49).
Gottingen University No. 48).
Istituto fisico Roma (No. 49).
Ecole Polytechnique, Paris (No. 49).
Electro Technical Institute of the Stuttgart Technical High School (No. 50).
Royal Astronomical Observatory, Munich (No. 49).
Earthquake Investigation Committee Imp. University of Tokyo, Japan (No. 49).
Munich Polytechnic (No. 49).
Kasan University (No. 48).
Kieff University (No. 48).
Paris University (No. 49).
Municipal Technical College, Manchester (No. 50).
Tomsk University (No. 49).
Petrograd Polytechnic (No. 50).
and to many others.

F.

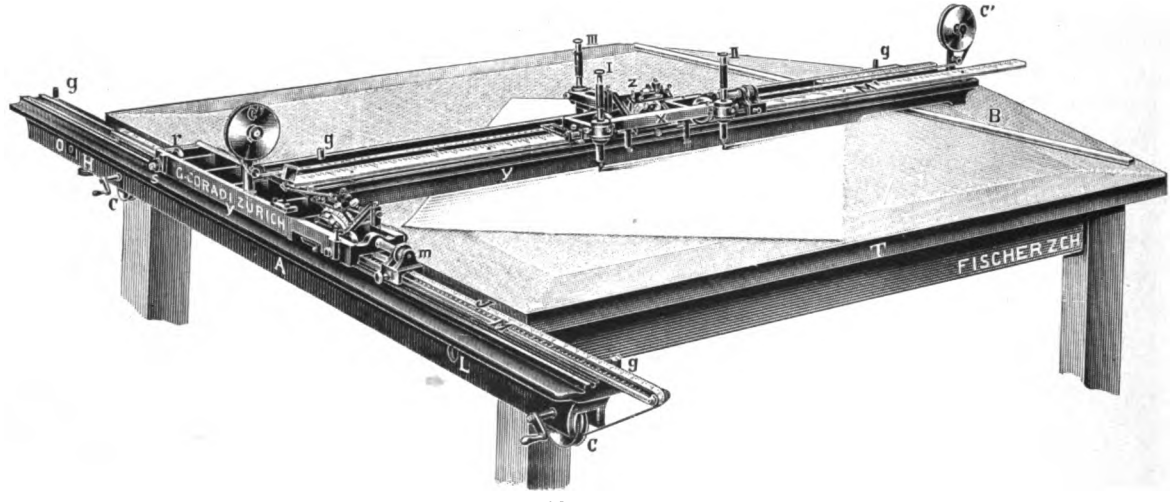
Coordinatographs.

Literature of Reference:

Stucki: Zeitschrift für Vermessungswesen, 16th Year, 1887, Page 538.
„ „ „ „ 22nd „ 1893, „ 369.
Prof. Dr. **E. Hammer,** Zeitschrift für Instrumentenkunde, Year XXII, 1902, Page 339.
Kummer, Zeitschrift für Vermessungswesen, Year XXXIV, 1905, Page 788.
Prof. **Weitbrecht,** Lehrbuch der Vermessungskunde, Volume I, Page 137 and 138.
F. Bühlmann, Zeitschrift des Vereins Schweizerischer Konkordatsgeometer, Nos. 6, 7 and 8, Year 1907.
Spaeth, Zeitschrift des Vereins höherer bayerischer Vermessungsbeamten, Volume 18, No. 4, Year 1914.

The coordinatographs are used for accurately marking the points of the net on survey plans and for accurately drawing the lines of the net directly by means of the drawing pen, either parallel or oblique to the edge of the sheet and also for protracting with the greatest accuracy the points lying within the nets of squares determined by coordinates. The apparati have been repeatedly improved by adopting suggestions made by various users, so that the illustrations do not absolutely represent the present construction.

Up to the present more than 100 instruments have been delivered in all parts of the world. Detailed instructions, testimonials and list of users will be sent free of charge on application.



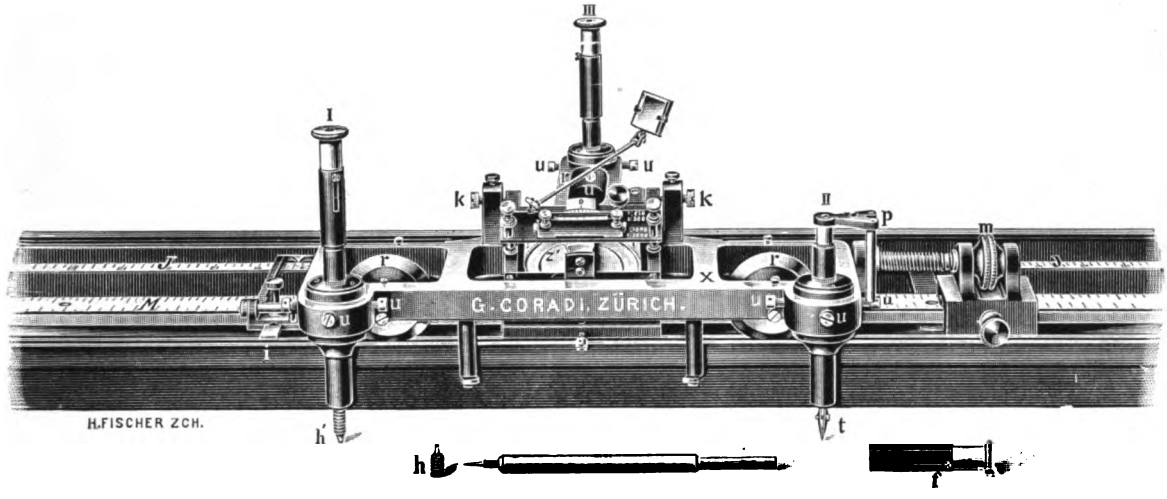
No. 51

When ordering coordinatographs the desired scale ratios should be stated.

No.

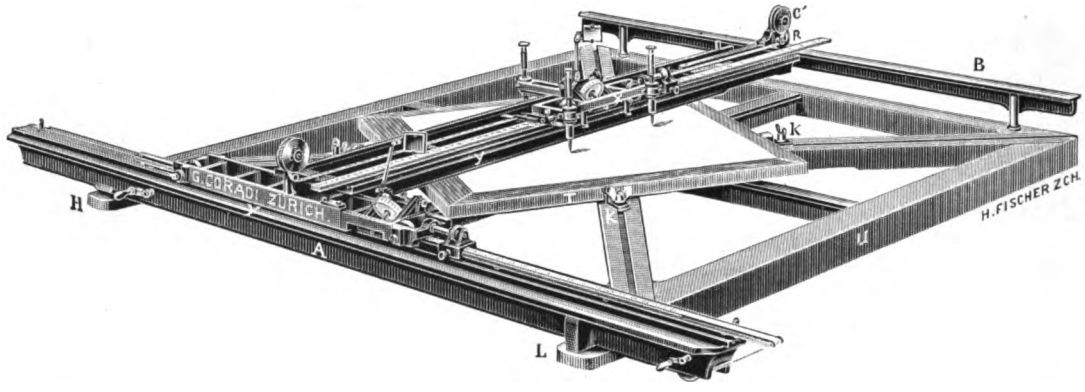
51. **Coordinatograph** of the size and construction most in demand (see illustration page 36).

On the board *T* the abscissa rule *A* of 1 m, 65 (66") length is fixed, in the groove of which the abscissa carriage *Y* on rollers can be displaced 1 m (40"). This carriage rests with a roller as a third point of support on an iron rule which is screwed on the edge of the board opposite the base rule; the board is now made the shape in of a square. The *Y*-carriage carries the ordinate rule, in the groove of which at a true right angle to the movement of the former carriage, the *X*-carriage can be moved a distance of 0,9 metre (36").



This carriage (see above illustration) carries three vertical pricking pins I, II and III (as those of my pantograph) which are kept suspended in their sleeves by means of springs. The points of pins I and II touch the same ordinate and have a distance of 200 mm (8") in the *X*-direction. The point of pin III has an ordinate distance of 100 mm (4') from I and II and an abscissa distance of 200 mm (8"). Therefore, by using the three pins I, II, III (see the schematic illustration in page 40) the *Y*-carriage is able to work on a length of 1,2 m. and the *X*-carriage on a length of 1,1 m. With the apparatus is supplied a drawing pen which can be so adjusted that it closely fits in the sleeves of the points I, II and III and has a free fall, so that its writing plane is either parallel to the ordinates or to the abscissae, the line which it draws passes exactly through the points of the net, so that the latter need not be marked by pricking. The two scales have graduations for two ratios (1 : 1000 and 1 : 500; 1" - 100' and 1" - 50') or any other desired ratios. In addition each scale is provided with accurate toothing in which measuring wheels engage which carry a graduated circle on which subdivisions of a meter or inch can be read in sevenfold enlargement, so that for instance an actual displacement of the carriages of $^1/_{10}$ mm appears on the graduated circles of the measuring wheels as $^3/_4$ mm. It is therefore also possible to mark with the greatest accuracy the measurements in the middle of the board without a magnifying glass (for instance on the scale: 1 : 1000 as far as 1 to 2 cm). The numbering is marked on a special band wound on rollers at both ends of the scales. The graduation of the bands can by turning these rollers, be made to directly coincide with the coordinate figures of the respective plan. With the instrument described plans of 1 m. (40") long and 66 cm (26") wide can be worked on in any desired direction.

Price with board but without frame . . . . . Fr.

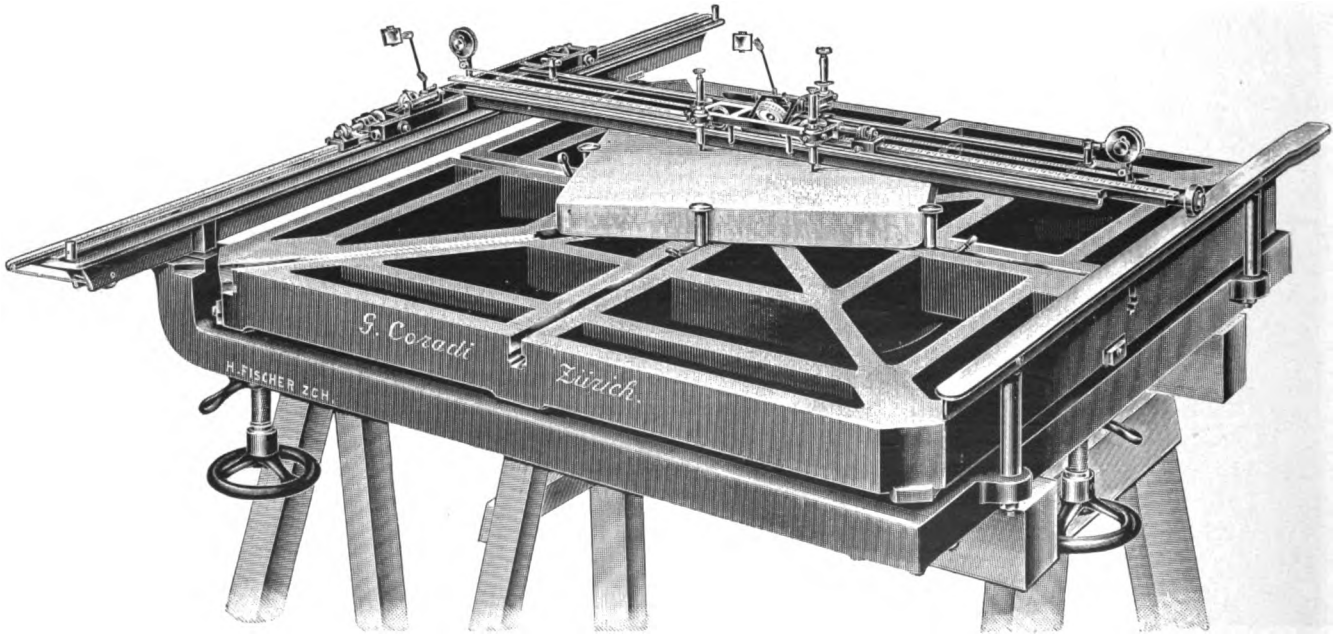


No. 51 a

No.

51. a) **Coordinatograph** as No. 51 but with an iron frame instead of the wooden board, on which are fixed the base rule and the rule *B* for the third roller of the large carriage. On this frame drawing boards or measuring boards up to 50 mm thickness can be fixed in any desired direction; the boards are pressed from below by means of 4 pairs of wooden wedges, against 4 metal angles which can be firmly screwed in the 4 grooves of the frame in any desired position. In this way the surface of the drawing board will always remain at the same height even when boards of different thicknesses are used. Only the overlapping parts of the fixing angle project above the drawing surface, over which the pricking pins in their suspended position can be passed without being damaged. This construction is particularly suitable for the tropics.

Price . . . . . Fr.



No. 51 aa

No.

51. aa) **Coordinatograph** as No. 51 a but with a frame consisting of two parts, of which the outer part carries the base rule and the rule for the third roller, whilst the inner part is arranged for fixing zinc plates, measuring boards, litho stones, which may vary in thickness from 50 mm to 1 mm. In order that the drawing surface may always remain at the right height, the inner part of the frame can be raised and lowered by means of 3 screws.

(6 of these apparati have been supplied to the Topographical Department of the Imperial Russian General Staff in Petrograd).

Price . . . . . Fr.

51 b) **Coordinatograph** as No. 51 or 51 a but each with two double affined scales, ergo for 4 ratios, i. e. 1 : 1000 and 1 : 2000; 1 : 2500 and 1 : 5000. Extra price Fr.

51 c) **Coordinatograph** as No. 51 for working on map sheets of 100×70 cm (40"×28") in a parallel direction to the edge only. The small carriage has a movement of 70 cm (28"). The board is correspondingly smaller. (Supplied to the Royal Bavarian Survey Bureau of Munich). Price . . . . . Fr.

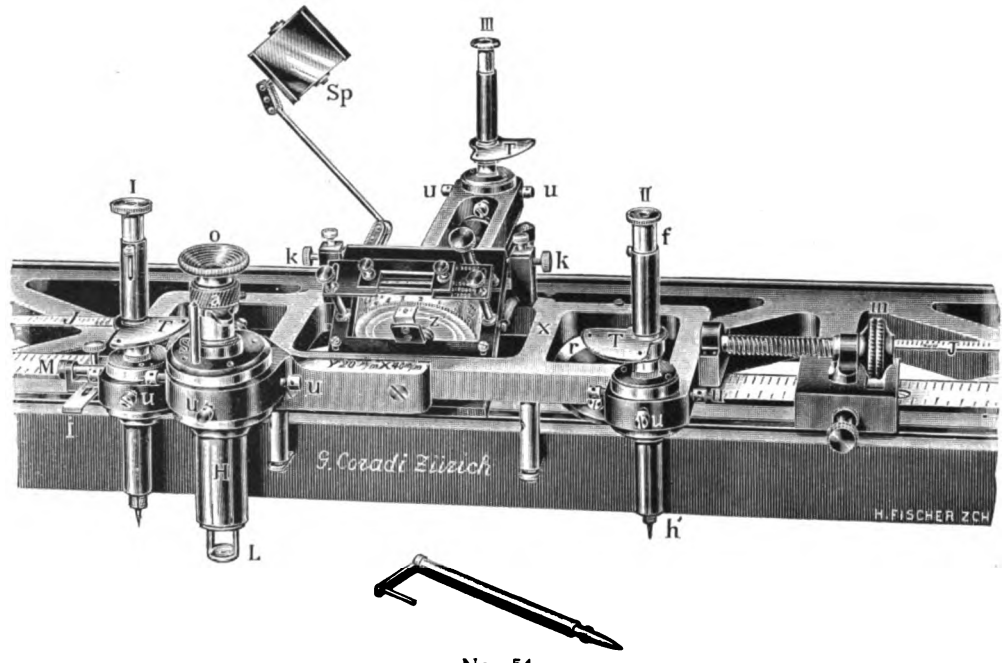
51 d) **Coordinatograph** as Nr. 51, arranged for working on map sheets of 110×87 cm (42½"×35") in any desired direction. The board has therefore a length and maximum with of 142 cm (57"). In order that it may be possible to protract easily and accurately also in the middle of this extended board its shape is sexangular and the rule *B* and the third supporting roller are placed **underneath the board.** (Supplied to the Municipal Survey Departement of Dresden). Price . . . . . Fr.

51 e) **Coordinatograph** with revolving, wooden drawing board on an iron support so arranged that the drawing board can be fixed in any desired direction. Map sheets of 90×120 cm (36"×48") can be worked on; the drawing board is only 2 cm (¾") longer and 2 cm (¾") wider than the map sheet; the third supporting roller and its guide rail are placed underneath the drawing board; in this way it is possible to protract easily and accurately also in the middle of the drawing, whilst the sheets of 87×110 cm (35"×42½"), which can be worked on with No. 51d with a non-revolving drawing board of 142×142 cm (57"×57"), represent the limit of the extension which a drawing board may have for protracting easily and accurately in the middle of the same. Price . . . . . Fr.

(On this principle instruments for larger maps can also be constructed at prices to be agreed upon).

51 f) **Coordinatograph** as No. 51 a but with a considerably stronger iron support and 4 strong tightening devices for fixing measuring boards, wooden drawing boards of a thickness of 2 cm (¾") and upward and heavy litho stones up to a thickness of 10 cm (4") by 70×110 cm (28"×44").

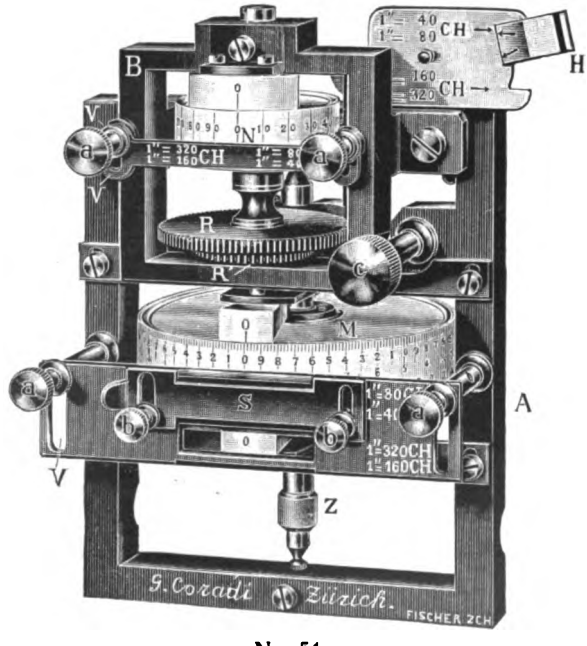
Price without wooden drawing board . . . . . Fr.



No. 51 g

No.

51. g) **Adjustment-Magnifying glass** with mark on the small carriage of the coordinatograph for reading the coordinates on finished plans and for examining the latter with a view to subsequent marking of points (see illustration No. 51 g). Price Fr.

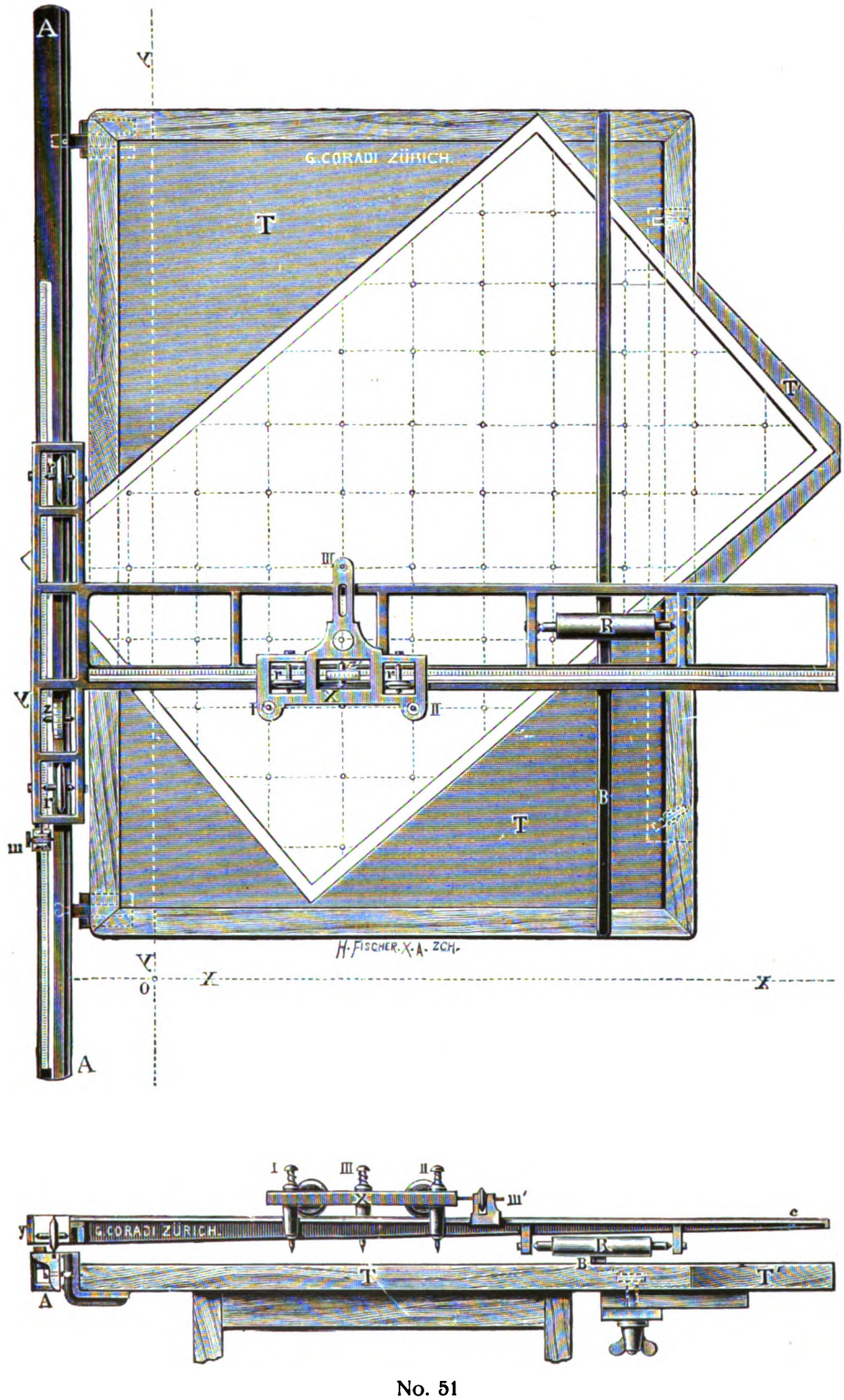


No. 51 g

No.

51. h) **Zero counting wheel** (see figure No. 51 h). It may happen that on very small scales the intervals for the units (10 metres, 100 metres) are so small and indistinct that it is too difficult to set the indexes on the graduations of the scale. This difficulty is obviated by fixing a counting wheel on the small measuring wheel; the axis of the counting wheel is provided with a graduated circle the intervals of which correspond to the zero points on the graduated circle of the small measuring wheel and are numbered accordingly. The intervals on the graduated scale then correspond to the zero points on the counting wheel. Price for 2 scales . . . . . Fr.

51. i) Price for 4 scales . . . „



No. 51
Diagrammatical representation of the coordinatograph.

Detail Coordinatograph and Coordinatometer.*)

Literature of reference:

Professor **Weitbrecht,** Lehrbuch der Vermessungskunde, Volume I, pages 135 and 136.
Professor Dr. **E. Hammer,** Zeitschrift für Vermessungswesen, 1909, page 291.
Dr. **Grunert,** Chief-Surveyor, Zeitschrift für Vermessungswesen, 1912, No. 6.

This apparatus was constructed only a few years ago and more than 70 instruments have already been supplied to public and private surveyors at home and abroad and it has everywhere met with the highest approval. It is constructed on the same principle as the large coordinatograph and is used for mapping the points rectangularly measured from the polygon sides, and for mapping curves, the abscissae and ordinates of which are given in scale figures.

The following illustration shows the apparatus in about $^1/_5$th of its actual size. A rather heavy cast iron frame rests on two steel rails (not shown in the illustration) which are covered underneath with paper and rest securely on the plan; the whole apparatus can be displaced on these rails by means of micrometer screws for setting the indexes $i\,i'$ on the measuring line, or the indexes $x\,x'$ on a line of the net. In the two extended sides of the cast-iron frame a rectilinear groove is accurately cut in which the carriage A can be easily moved by means of two rollers with double cones. Parallel to this groove the abscissa rule C is placed in a guide groove in which it can be displaced about 15 mm by means of the micrometer screw E. On the abscissa rule C moves the sleeve E' with thrust and micrometer screws for the carriage A, by means of which it can be gripped and accurately set at any desired point.

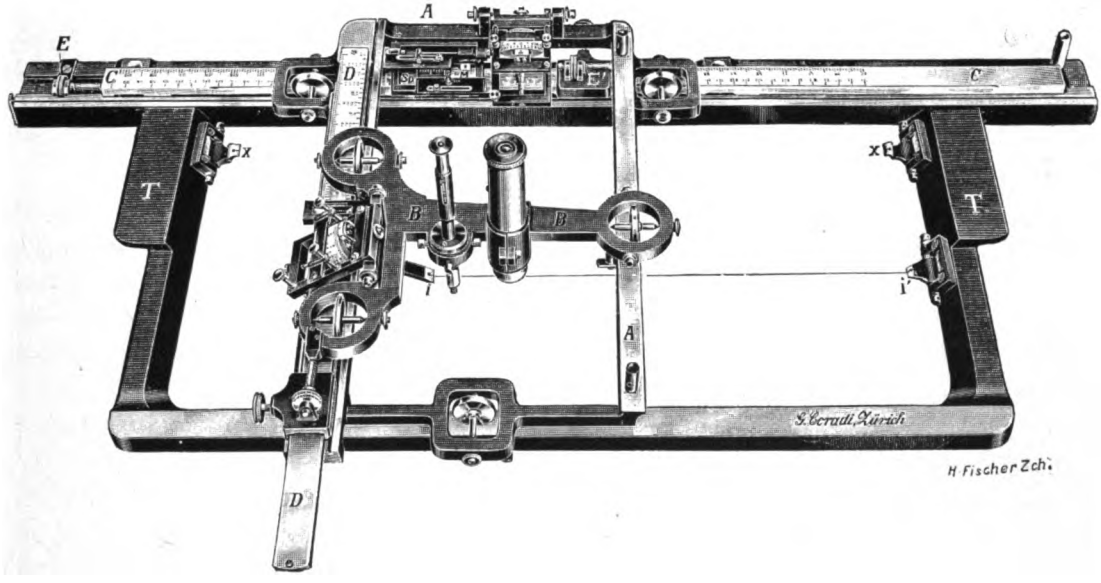
If, after the micrometer sleeve has been gripped, the abscissa rule C is displaced by means of the micrometer screw E at the end of the abscissa rule, the latter is moved together with the carriage A, the setting remaining at zero of the graduation of the abscissa rule.

On the longitudinal side of the carriage A there is likewise a groove and parallel to this the fixed ordinates rule D; the groove and rule are exactly rectangular to the groove in the large frame. In the groove of the frame A moves the small carriage B which can be gripped and accurately set by means of the micrometer sleeve on the ordinates rule D.

The bevelled edges of the two scale rules C and D are provided with a microscopically exact toothing in which small toothed wheels in the small frames engage; the small frames can be turned round a horizontal axle formed by two pointed screws and cause, by means of their overweight, which is increased by a spring, the small toothed wheels to correctly engage in the racks of the two scale rules. On the axes of the microscopically exact small toothed wheels cylindrical graduated circles of celluloid are placed, the diameter of which is about 10 times larger than that of the small toothed wheels; a displacement of $^1/_{10}$ mm of the two carriages accordingly appears on the graduated circles in graduated intermediate spaces of 1 mm.

*) List of buyers will be sent on application.

Each of the two scale rules are provided with two affined scales (for instance 1 : 1000 and 1 : 500 or 1 : 400 and 1 : 200 etc.). The intermediate spaces on the scales correspond to the zero points on the graduated circles of the small toothed wheels, so that when the index of the graduated scale is on a point, the index of the graduated circle points on a zero point; if this is not the case the small toothed wheel must be disengaged by means of the lifting screw in the small frame and then set at zero and again thrown into gear. According to the ratios on the instrument the graduated circles can have one or several zero points. With a view to quickly setting the instrument the carriages can be moved freely until the desired unit point appears on the index of the graduated scale, after which the graduated circle must be observed and the subdivisions adjusted up to one graduation point and only then will it be necessary to use the micrometer adjustment for adjusting the last $^1/_{10}{}^{th}$ mm. The graduations on the abscissa rule *C* are only numbered in one direction; the zero point is on the left hand side of the operator (on the right hand side in the illustration).



If desired double figuring can be provided with zero right and left. The graduations on the ordinates ruler *D* are so arranged that the figures commence with zero in the centre and progress to the left and right, the figures on the left being in black colour and those on the right in red colour. For reading the coordinates a further red row of figures is provided with zero at the left end.

The figures on the graduated circles corresponding to the figures on the scale rules are likewise red and black so that it is impossible to make mistakes. In order not to confuse the graduations on the graduated circles a small adjustable plate is placed over the same by means of which the graduation not used can be covered. On the small carriage *B* there is a pricking pin which is kept suspended by means of a spring and has a free fall in its sleeve, and a micrometer; the hair-cross of the latter

and the point of the pricking pin are in the line given by the indexes *i* and *i'* when the index of the carriage *B* stands at zero of the ordinates rule. On the large carriage *A* there are two indexes for each graduation having a free fall in a small frame, the distance of which from each other is equal to the distance of the point of the pricking pin from the point of the plan covered by the hair cross of the microscope. If readings are to be effected by means of the microscope or the instrument is to be set at zero of the measuring line, the index marked „Mikroskop" should be used; when working with the pricking pin, i. e. when protracting points, the index marked „Spitze" should be used. A device is provided for covering the index not in use.

For carrying the instrument and for approximately adjusting the same on the plan, the two arms *T T* on the large frame should be used; when carrying the instrument it is advisable to lock the two carriages. **Quick and jerky movements of the two carriages must be strictly avoided.** When the small measuring wheels are not in use they should be disengaged by means of the lifting screws. The axes of the small measuring wheels and all the rollers must move easily and without any play.

The detail coordinatograph above described possesses the following advantages as compared with similar instruments and devices now in use:

1. By means of this instrument a much greater accuracy can be obtained with less trouble and loss of time than with any other intsrument, device or method; this is of special importance for town surveys where so many points have to be marked in one operation with great accuracy.

2. The instrument can be adjusted quickly and with great accuracy on the measuring line and on the initial point of the same, whereby a destruction of the initial point by the pricking pin is avoided, as the adjustment on the line and the adjustment on the zero point are two separate operations, of which the former is carried out by means of micrometer screws and the latter by means of microscope and micrometer screws with the greatest accuracy and speed.

3. The measurements can be accurately set and protracted from one to two hundredparts of a millimetre (1 to 2 cm on the scale $^1/_{1000}$) without it being necessary to use a magnifying glass, as when reading and setting verniers when there is always an inaccuracy of from 1 to $^1/_2$ tenth of a millimetre. This arrangement consisting of small measuring wheels, which has everywhere met with approval and proved excellent in the long run, enables the work to be carried out with greater accuracy and speed without strain to the eyes of the draftsman which is an advantage of the greatest value.

4. The movements of both carriages of the instrument are so light that the working is exceedingly easy. This light running of the carriages will not change even when the instrument has been in use for a long time as the carriages move on conical rollers; the instrument is of sufficient weight to avoid a displacement of the same during the work.

5. The plan will remain much cleaner (as many users have assured me) than when using other instruments which have to be shifted on the plan.

General rules for using the instrument: By means of the two indexes *i* and *i'*, which can be raised, and the two micrometer screws on the two supporting rails the

No.

instrument is placed on the measuring line (polygon side) so that the index *i'* partly covers the initial point (zero of the line, measuring zero) so that the index can be set exactly on the line.

The carriage *A* is set at zero of the adjustable scale *C* by means of the index marked „*m*" (Microscope) and the micrometer screw *E'*.

By means of the microscope the carriage A is adjusted in its zero position and the adjustable scale *C* placed at the measuring zero point, which becomes visible by raising the index *i'*, by means of the micrometer screw *E*, which will make the zero point of the graduation on the scale *C* correspond with the zero point of the measuring line. **Consequently it is not necessary for this purpose to shift the whole instrument which would upset the adjustment.**

By displacing the covering plate *K* the index marked „*m*" (Mikroskop) on the scale *C* is covered and the index „*sp*" (Spitze) made visible. The distance between these two indexes is exactly the same as that between the axis of the microscope and the pricking point; when the index „*sp*" is adjusted on the graduation zero point by displacing the carriage *A*, the pricking point is brought to coincide with the zero point of the measuring line and the operator can then commence to mark the points in the usual way to the right and left of the measuring line.

In order to read directly on the plan the coordinates for those points, of which the coordinates are not determined, the instrument must be so adjusted with the two indexes *X* and *X'* on a line of the net that the index *X'* evenly covers a point of intersection of two lines of the net.

In order to bring the microscope to coincide with the junction line of the two indexes *X* and *X'*, the carriage *B* is adjusted on the zero point at the beginning of the graduation of the scale *D*. The further adjustment of the axis of the microscope on the intersection point of the line of the net is effected in the same manner as above described. The readings on the small measuring wheels added to (or subtracted from) the coordinates of the two net lines now give directly the coordinates of the points adjusted with the microscope.

The pricking pin must always be kept clean in order that it may always fall free and be kept suspended by the spring; the pin must not be oiled. When it is not held up by the spring it must be cleaned with clean tissue paper and the casing must likewise be cleaned by rolling up a piece of tissue paper and drawing it through the casing.

The surface which can be worked on by the pricking pin of the instrument is 49×22 cm (19½"×8¾").

52. **Detail Coordinatograph** as described above with case . . . . Fr.

52. a) **Detail Coordinatograph** as No. 52 but larger in every respect; the pricking pin can work on a surface measuring 500×450 mm (20"×18"). (Supplied to the Ministry of Finance Bucharest). Price with case . . . . . Fr.

No.

52. b) **Detail Coordinatograph** as No. 52 but provided with verniers on the scale graduations instead of the small measuring wheels, the price being correspondingly lower; the advantage, however, offered by the arrangement of the small measuring wheels in regard to accuracy, quick working, distinctness of the graduation and minimum of strain to the eyesight is so great that of the instruments supplied up to the present (about 70) only one single instrument with vernier reading was ordered, namely for protracting curves.

Price of the instrument with vernier reading . . . . . Fr.

53. **Detail Coordinatograph,** small type. The pricking pin is able to work on a surface of 210×110 mm (8½"×4½"). Instead of the microscope it is provided with a free falling adjustment magnifying-glass with glass mark resting on the drawing (as shown in figure No. 51 g). The instrument is suitable for protracting in small scale ratios (1 : 2500 — 1 : 10000).

Price for 2 scale ratios and case . . . . . Fr.

54. **Detail Coordinatograph** as No. 53 but of simpler construction. The abscissa scale is not adjustable; the adjustment on the zero point of the measuring line is effected by means of the edge of the index *i*, which can be raised, and the magnifying-glass fixed above same. It is not provided with a microscope.

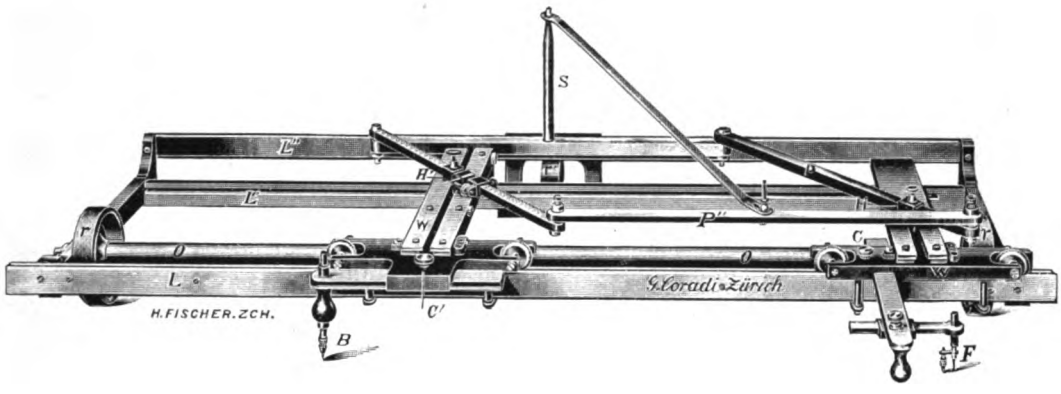
Price for two scale ratios and case . . . . . Fr.

55. **Figure Band.** The detail coordinatographs No. 52 and 52 a can be so arranged that the figuring of the scales is carried out on movable figure bands as in the large coordinatographs, so that the figuring can be brought to coincide with the coordinates of the corresponding plan. In consequence of this the case will be about 10 cm (4") longer and wider. Extra price . . . . . Fr.

The detail coordinatographs are only arranged for two affined scales.

Affinograph

Designed by Prof. C. O. Mailloux, New-York.



No.

56. The instrument shown in the above illustration is intended for reducing and enlarging the ordinates of curves in given ratios as desired; for instance for giving a uniform width of constants to curves of the same kind, but originating from different indicators, in order to facilitate the comparison. The instrument is also an Ellipsograph; if the one pin describes a circle then the other pin draws an ellipse in proportion to the reduced or enlarged ordinates.

In the x-direction the instrument can travel to any desired length; in the y-direction the guide pin can travel to a maximum length of 33 cm (13"). Price . Fr.

LIST

of pamphlets relating to mathematical instruments.

Of the pamphlets marked with * a copy is supplied with each corresponding instrument; the pamphlets marked with ** can be obtained from me at the prices stated.

No.			
* 100.	**G. Coradi:** The freely suspended Precision Pantographs	Fr.	—.50
* 101.	Do. German edition	„	—.50
* 102.	„ French edition	„	—.50
** 103.	**C. W. Hoffmann,** Gebruik en Opstelling van den Vrijzwevenden Pantograaf	„	—.50
* 104.	**G. Coradi:** The Coradi Planimeters, description and instructions for using and testing the same, with an elementary, general explanation of their use	„	1.—
* 105.	Do. French edition	„	1.—
* 106.	„ German „	„	1.—
* 107.	„ Italian „	„	1.—
** 108.	**Hans Mettler,** Maschineningenieur: Graphische Fragmente, enthält die Anwendung des Planimeters zur Auflösung hydrotechnischer Aufgaben, mit 7 graphischen Tabellen	„	2.—
* 109.	**Henry Lossier:** Der Integraph Abdank-Abakanowicz (Beschreibung, Theorie und Anwendungsbeispiele)	„	1.50
* 110.	Do. French edition	„	1.50
* 111.	**G. Coradi:** Der harmonische Analysator, mit einer Theorie von Professor O. Henrici	„	—.50
* 112.	Do. French edition	„	—.50
* 113.	**G. Coradi:** Description and instructions for using the Coordinatograph	„	—.50
* 114.	Do. French edition	„	—.50
* 115.	„ German „	„	—.50
** 116.	**Bühlmann:** Die Berechnung der Koordinaten der Grenzpunkte (enthält zugleich eine kurze Beschreibung und Mitteilungen über die Anwendung des Koordinatographen auf dem Vermessungsamt der Stadt Zürich)	„	1.—
** 117.	**Spaeth:** Der freirollende Koordinatograph; enthält geschichtliche Daten und rationelle Genauigkeits-Untersuchungen	„	—.50
* 118.	Dr. **Grunert:** Coradi's Detail-Coordinatograph	„	—.50
* 119.	Do. French edition	„	—.50
* 120.	„ German „	„	—.50

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